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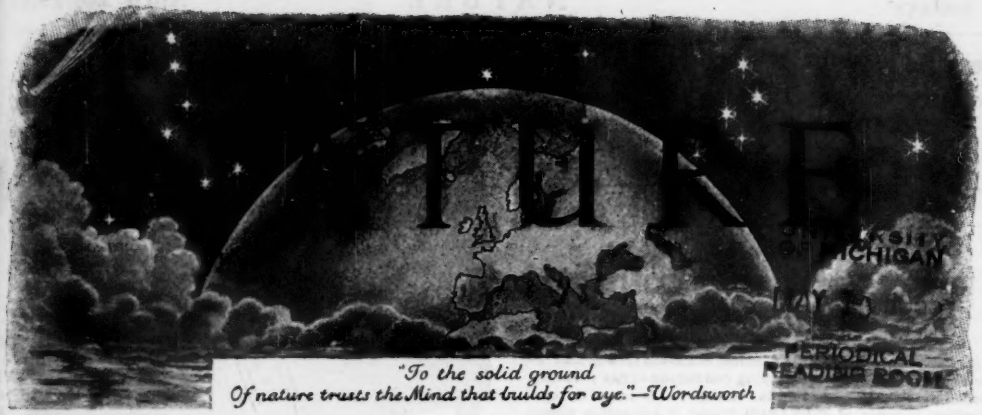

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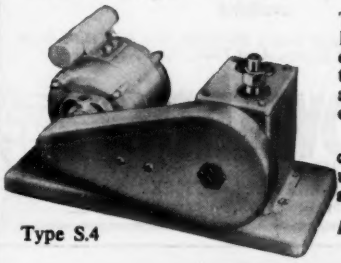

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NATURE

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BIOLOGICAL HAZARDS OF RADIATION

IN the same week as the "Statement on Defence, 1955" and the White Paper "A Programme for Nuclear Power" were published in Great Britain, the Atomic Energy Commission of the United States issued a long and detailed report on the radiation and 'fall-out' produced by thermonuclear explosions. In the following week, the Federation of American Scientists communicated proposals, for an international study of the potential dangers in tests of nuclear weapons, to the Office for United Nations Political and Security Affairs of the Department of State and to Mr. H. Cabot Lodge, the United States representative at the United Nations. The text of the latter proposal for the establishment of a United Nations Commission to study and assess the potential dangers in such tests was published in *The Times* of March 24; but the proposal had become known in the meantime and was one prime cause of the stream of questions in the House of Commons on this matter during recent weeks.

A contributory factor was the admission in the White Paper that the Government had not yet been able, with the information in its possession, finally to assess the implications of the latest developments in weapons, and particularly the extensive radioactive contamination which may be caused by the 'fall-out' from a thermonuclear bomb burst at ground-level. Lack of frankness on the Government's part has led to what may well be unavoidably incomplete knowledge being construed as resulting from lack of interchange of vital information between Britain and the United States, and from failure to implement the necessary research with sufficient urgency and resources. No explanation, for example, has been given as to why the information from the Atomic Energy Commission was not made available earlier to the British Government, or, if it was, why no account was taken of that information. Even as late as March 22, written answers to questions in the House of Commons on research in radiobiology and on the effects of radioactivity upon reproductive cells seem unrealistic.

When on March 10 the Prime Minister was asked in the House of Commons to take the initiative and to propose the establishment of a United Nations Commission to study and assess the potential dangers to human beings from nuclear tests throughout the world, including long-term tests, Sir Winston replied that experts at the disposal of the Government saw no reason to dissent from the opinion of the United States Atomic Energy Commission's report, issued on February 15, that the tests so far carried out have only released enough radioactive material into the atmosphere to cause an individual living in the United States to receive the same quantity of radiation that he would have received in an X-ray chest examination at a hospital. He added that an extensive programme of research on the genetic effects of exposure to varying levels of radiation was already in progress both in Britain and in the United States of America; but that, in making its proposal for an immediate study of the potential genetic risks of nuclear weapons, the Federation of American Scientists appeared to be envisaging dangers from a number of tests greatly in excess of those likely to be carried out in the foreseeable future.

This question of radiation effects is unfortunately being confused or intermingled with the moral or political question of the use of thermonuclear weapons, and with the practical question of the prohibition or limitation of thermonuclear test explosions. Sir Winston, for example, was asked at the same time to propose the establishment by the United Nations of an international monitoring service to detect atomic and thermonuclear explosions, and also the limitation of the number of such tests in view of the "fact" that continued tests "may" lead to long-term damage to the human race through a general world-wide contamination of the atmosphere. The Archbishop of York's important speech in the Defence Debate on March 16 followed immediately on one in which Lord Alexander of Hillsborough had testified to the general anxiety as to growing dangers to the human race from increasing thermonuclear experiments and their genetic and physical effects; but the statement by men of science of all nations of the consequences of nuclear warfare which the Archbishop advocated is obviously something more comprehensive and purely factual.

It is unfortunate that Sir Winston, like Mr. J. R. Bevins, who, in a written answer on March 7, ignored the question as to what research is being conducted on the radioactive content of the atmosphere of London, denied that there is any evidence of a significant increase in recent years or that radioactivity is a contributory factor in bronchial cancer, declined to admit that as yet we know very little about the long-term biological effects of radiation. Mr. C. R. Attlee's admission of our ignorance gives the more force to his suggestion of an authoritative statement made by scientists drawn from both sides of the Iron Curtain, and no convincing reasons were advanced in the following debate on March 14 or afterwards in the House of Lords as to why the attempt should not be made. The subject will be discussed during the forthcoming International Conference on the Peaceful Uses of Atomic Energy to be held at Geneva in August; but this Conference will be confined to scientific and technical discussions.

The situation has been clarified a little by a subsequent debate in the House of Commons, on March 22, on the genetic effects of nuclear explosions. The motion moved by Dr. Edith Summerskill wisely refrained from linking the acquisition of further information with the immediate cessation of all test explosions; while expressing fears as to long-term dangers to humanity as a result of continuing radioactive contamination of the atmosphere arising from continuing nuclear explosions, the motion merely urged the Government to give further consideration to those long-term effects and to call a conference of scientists from the United States, the

U.S.S.R., the United Kingdom and France to advise on the danger facing mankind. Meanwhile, in a written answer on the same day, Mr. J. R. Bevins had stated that the Medical Research Council's Radiobiological Unit at Harwell is carrying out a large programme of research on the effects upon the germ cell of exposure to radiation. Related studies are in progress in other establishments of the Council, and the programme aims at extending our knowledge on all the hazards which radiation may hold for human beings. The Medical Research Council has since been asked to prepare a report on the subject which is to be issued as a White Paper; and in the United States, it is announced that the National Academy of Sciences will undertake a broad appraisal of present knowledge about the effects of atomic radiation on living organisms, with financial support of the Rockefeller Foundation.

The amendment to Dr. Summerskill's motion, moved on behalf of the Government by Mr. Ian Macleod, welcomed the Government's decision "to continue and expand research in this country on the medical and biological aspects of nuclear energy, and to collaborate by every practical means with those countries with whom arrangements already exist and with such others as can usefully be brought into consultation". This decision, moreover, was set in the context of the intensive efforts which are being made to achieve a comprehensive scheme of disarmament and not in the context of a conference of scientists; and while the arguments from the Government side did not entirely dispose of the idea of a world conference on the scientific aspects of biological effects of radiation, there is clearly room for two opinions as to the value of such a conference. Even if, however, it produced nothing of scientific value, it might still be worth holding to see whether the U.S.S.R. would face or evade the issue of making known even behind the Iron Curtain the probable consequences of nuclear warfare and of the continuance of tests of thermonuclear bombs.

The Government amendment was carried at the end of a debate which was remarkably free from party politics and which was sufficiently objective to clarify some of the confusion between the political and the scientific issues. The desire for an agreed statement by scientists drawn from as wide an area as possible was manifest in all the speeches, even in those most sceptical as to the value or practicability of including Russian scientists. The Minister of Works, Mr. Nigel Birch, winding up for the Government, pointed out that the debate had been essentially concerned with the possible dangers of radioactivity caused by events short of war. To Mr. Macleod's account of the research already in progress, Mr. Birch added the further assurance that, although considerations of security did sometimes impinge to some extent, all the relevant research on biological effects of radiation is, or will be, published. He also indicated that there is excellent co-operation in this field with the United States and Canada, where knowledge and experience are even greater than ours. He thus largely met the important point made by Mrs. Barbara Castle, who referred to Prof. C. H. Waddington's plea, in *The Times* of March 10, for more research, on a massive scale, on the long-term effects of low-intensity irradiation of mammalian populations, since this is a field demanding international co-operation and resources.

Prof. Waddington, whose plea for more research was afterwards strongly supported by Dr. H. Motz, expressed doubts whether Great Britain alone could devote to the problem resources commensurate with its importance; and he added that it is not a matter for any single country. Meanwhile, existing knowledge suggests that any increase in the level of ionization at centres of population would add its quota to the load of harmful hereditary factors which mankind has to bear. Prof. Waddington and Dr. Motz, Prof. H. W. B. Skinner and Prof. P. G. 'Espinasse and others have emphasized the limitations of our present knowledge and the inadequacy of our understanding of the probable magnitude and nature of the long-term genetic effects in man of atmospheric ionization produced by nuclear bomb tests.

In the course of his speech, Mr. Macleod gave the expenditure on such research by the Medical Research Council for 1955–56 as £208,000, and said that any recommendation by the Council, after reviewing the research programme in the light of new commitments, would be favourably considered. He added that present results have established that radiation produces genetic effects and the radioactivity of the planet has slightly increased as a result of nuclear bomb explosions. Genetic research, however, is inevitably slow, and while our present knowledge is insufficient to fix precisely the level of radioactivity above which genetic damage would significantly affect the well-being of populations, it is most unlikely that the present increase would have any appreciable genetic effect. It was a more detailed statement of this order that Mr. Elliot and others wished to see embodied in a White Paper.

The position which Mr. Macleod took up is thus roughly that of the United States Atomic Energy Commission, from the report of which he quoted in full paragraph 40, which has already caused much controversy, partly through inaccurate quotation. After this debate the Government can scarcely be accused of indifference to the manifest public anxiety; but if there is any undue delay in producing the White Paper which has now been promised from the Medical Research Council, scientists have their own responsibility for relieving anxiety as to some of the questions raised both by the Atomic Energy Commission's report and the comments on that report by the Federation of Atomic Scientists. Such action indeed is imperative if public opinion is not to be confused, or policies and action urged on the Government which are conducive to neither national security nor national welfare.

From the medical side, one such attempt has already been made in the *British Medical Journal*, which in a leading article on March 26 put concisely and clearly the limitations of our existing knowledge, the factors of which the United States Atomic Energy Commission report appears to take insufficient account, and the directions in which further know-

ledge is urgently needed. Although that report indicated the real magnitude of the radiation hazards associated with the testing of nuclear weapons, it dealt chiefly with the damage caused by the 'fall-out' or deposition of radioactivity in the vicinity of the explosion. For the Bikini test this amounted to some 20 million röntgen square miles, covering an area of 7,000 square miles, serious danger being limited to a belt 140 miles long and 20 miles wide; but on the important problem of radioactivity other than in this fall-out, the report says nothing. For thermonuclear bombs of the type now available, the fall-out could well be five times as great; and although much of the radioactive mist reaches very great heights, we know very little about the movement of the atmosphere at such heights. Moreover, even if the radioactive dust takes as much as six months to settle instead of six days, the residual radioactive dose may be reduced only by one half. There is also the important question of how long such radioactive dust remains on the surface before it is washed away.

Answers to such questions as these are not to be obtained readily, and though the evidence is as yet insufficient for definite conclusions, as the Federation of Atomic Scientists admits, it is possible, if not probable, that continuation of nuclear bomb tests on the present scale would double the natural amount of atmospheric radiation. Even this may well be too low to cause much genetic damage; but it cannot be said that continuance on the present scale over many years will not constitute a serious genetic hazard, and for that reason alone the Federation of American Scientists stresses the urgent need for intensive study of the problem of radioactive contamination resulting from bomb tests. Major responsibilities of the United Nations Commission which it is proposed should be established would be to obtain scientific data and expert opinion on the magnitude of the radiation intensities involved; to obtain and evaluate scientific opinion on the biological and genetic effects of radiation on human beings and to establish an agreed danger threshold. The results of this study would be reported to the General Assembly of the United Nations, with recommendations as to the procedures required to avoid exceeding the danger threshold.

This proposal thus appears to be eminently practical and to be free from the political complications which would attend unilateral decision, on present evidence, by the United Kingdom or the United States, to discontinue nuclear test explosions. They have been endorsed essentially by Prof. J. Rotblat in an article in the March issue of the *Atomic Scientists' Journal*, in which he specifically urges publication by the Government of all known data about the genetic effects of radiation resulting from the nuclear bomb tests. The important point is that existing information should be made known as widely and fully as possible, with a clear explanation to the non-scientist as to its exact implications. Unless this is done urgently and efficiently, it is clear that public opinion could easily be confused and stampeded into measures inconsistent with either health or security.

In that task of interpretation and exposition the scientist has an important part to play. On him, too, lies largely the responsibility for constructive criticism of any measures which the Government may propose, not least in respect of the adequacy of the resources allocated to research in this field, and of the extent of international co-operation in such research and the promptness and efficiency with which results are exchanged. To the scientist also the nation must look for guidance as to the completeness with which the field is being covered and the directions in which further research is most urgently required. The adequacy and the disposition of the resources made available for research will be influenced very considerably by the vigilance and public spirit of scientists in general, and to them the public must look, not only for the assurance that the gaps in our existing knowledge will be filled as completely and swiftly as is possible, but also for guidance as to the measures required to safeguard mankind from the real hazards with which we are at present confronted.

DAVID HUME: A BIOGRAPHY

The Life of David Hume

By Prof. Ernest Campbell Mossner. Pp. xx+683+20 plates. (Edinburgh and London: Thomas Nelson and Sons, Ltd., 1954.) 42*s.* net.

HUME's importance warrants a biography, his travels and varied activities provide the stuff of one, and surviving records are ample enough to make one possible. Over the dull lives of many philosophers time has drawn a sponge; but Hume was more than a philosopher, inserted himself into diverse circles, was a 'character', had many big friends and more petty enemies, and consequently was widely mentioned. One indication of his prominence is that a large number (apparently a large proportion) of his letters have been preserved. The ample material was worked up into a lengthy biography in 1846 by John Hill Burton, and digested afresh in a shorter "Life" by J. Y. T. Greig (1931). The least that this book by Prof. E. C. Mossner proves is that the extant material is even ampler and more widely scattered than we had known: with immense skill and industry he has brought new things out of old sources and tracked down new sources, checking what his predecessors have written and adding to it considerably. Further, holding a chair of literature (in the University of Texas), he knows how to present his material. The total result is a rich, illuminating and absorbing volume, which must be immediately acknowledged as the standard biography of Hume.

Hume lived before the higher learning was broken into bits. This is one reason why it is good for us to read him. He studied at least the elements of mathematics and physics at Edinburgh, the first university outside Cambridge to teach Newton's "Principia". He had a close acquaintance with the Greek and Latin authors (not only those that are known as classical), was nearly as much at home in French as in English literature, and read some of the Italian writers. He composed a much-read "History of Great Britain" (in six quarto volumes) that set a new standard of both objectivity and width of human interest, and wrote some pioneering and penetrating essays in economics and some admirable ones on political science; and in these as in his philosophical

works he wrote a straightforward yet elegant prose that is an admonition to us specialists who have made the language of education barbarous.

As a philosopher, Hume should be congenial to scientists, for he expresses emphatically the critical and cautious spirit of science. It is not an accident that one of the good books on him was by T. H. Huxley (in the "English Men of Letters" series). Hume was an admirer of Newton's achievement in pulling together a vast field of phenomena by means of the principle of gravitation not postulated as an occult force but proved as an empirically verifiable uniformity; and it was this brilliant success of scientific method that prompted him to search for a comparable law in the sphere of mind. This means that his primary aim was to establish psychology as a systematized natural science; and the comprehensive law which he propounded and believed he had verified, the law of association, remained the Ariadne-thread of British psychology until after the middle of the nineteenth century. In his psychologizing, however, he kept turning aside to philosophical problems, and either tore them to pieces or pronounced them to be insoluble. His general principles here were: (*a*) that reason can do no more than discern the logical relations of ideas, from which no inferences about existence can be demonstrably drawn; (*b*) that existence is known to us only in subjective data, the regularities of which can be noted but not explained; and consequently (c) that belief in anything behind the data of the senses, though the belief is inexpugnable and sane, is incapable of being proved. This anti-metaphysical contention makes Hume one of the heroes of the contemporary British positivists, and should appeal to those students of science who would like to find philosophical reasons for not giving a realistic meaning to the entities and relations of theoretical physics.

The literature on Hume's thought being considerable, Prof. Mossner has addressed himself to the events and *milieu* of Hume's life, which have not been written about much and which, he shows abundantly, called for a fresh investigation. He has recovered them with a remarkable wealth of detail, authenticated by precise references to contemporary or nearly contemporary sources; and he has allowed the interest to arise from the detail and its concatenation, instead of plastering it on with clever phrasing and pseudo-profundity of comment. He presents Hume, not himself. He recreates the intellectual life of Edinburgh, Hume's real home between his various moves, and the exquisitely civilized gatherings in the *salons* of Paris, where, not as an official of the British Embassy but as a proved thinker and writer, Hume was received with extraordinary honour. It is interesting to read for the first time a circumstantial account of the military expedition to Brittany in which Hume took part, and the new things that are told of his diplomatic work in Paris and of his spell in London as Under-Secretary of State. Good sayings and good stories punctuate the long narrative. Hume emerges through it all as a man of sense, humour, honour and benevolence. The source of his intellectual precocity remains hidden: presumably it was in himself, not in his environment. As in other good biographies, we are taught a period of history concretely and humanely, and therefore probably more truly than in the general sweep of the history books with which most of us are familiar.

The publishers have given this important piece of research a worthy dress: binding, printing and illustrations are all of a quiet excellence, and it is a delight to see again margins of the pre-war width. The volume will have to be put as a matter of course in every university and large public library; every Scot should have it in his own; and every lover of scrupulous yet lively biography may well expose himself to the temptation of it. T. E. Jessop

TOWARDS A HANDBOOK OF CRYSTALLOGRAPHY

Crystal Data

Classification of Substances by Space Groups and Their Identification from Cell Dimensions. By J. D. H. Donnay and Werner Nowacki, with the collaboration of Gabrielle Donnay. (Geological Society of America Memoir No. 60.) Pp. ix+719. (New York: Geological Society of America, 1954.) n.p.

I FIND it amusing to open this book almost at any page and to consider what accidents of crystal chemistry and recent history have brought together, side by side: hæmoglobin and lead monoxide hydrate, for example, or hydrogen iodide, xenon and barium fluoride, or β-sitosterol H_2O (from rubber) and 4:5-antimony sulphide – lead sulphide. For this book is a compendium of all the variety of X-ray measurements on single crystals which have been collected in the past thirty odd years, nicely mixed together through the operations of classification by crystal symmetry and crystal axial ratios.

The book is a practical demonstration of the extent of the problem as it now exists of making a collection of crystal data. It includes measurements on nearly six thousand crystals studied for a variety of chemical and crystallographic purposes. The mere process of grouping them together as Prof. W. Nowacki does in Part 1 of the book, by space groups, underlines the arbitrary character of the existing material. This does not mean that the formal conclusions that might be drawn from Nowacki's lists are necessarily wrong. The commonest four space groups found among organic compounds, for example, are $P2_1$ (127), $P2_12_12_1$ (144), $P2_1/c$ (355) and *Pnma* (192), of which the first two are particularly appropriate for the packing of asymmetrical molecules. Prof. Nowacki fears that crystallographers avoid triclinic crystals, and hence these appear less commonly in measured examples than they do in Nature. Actually, from my own experience, I should say that triclinic crystals really are considerably less common than monoclinic and orthorhombic; and $P2_1/c$ particularly is so dominant among space groups that a suspicious character like myself, looking at a list of examples of compounds said to belong to $P2/m$, immediately wonders if some have been wrongly measured—one at least, creatinine, really has got the space group $P2_1/c$ according to later observations (private communication from H. Mendel). Among inorganic compounds, on the other hand, the most common groups, face-centred cubic and close-packed hexagonal, probably do reflect the accumulation of data on simple substances up to the present. Extensions to come will certainly add considerably to the numbers here in lower-symmetry space groups.

The largest part of this book, Part 2, is the list, compiled by Prof. J. D. H. Donnay with Dr. Gabrielle Donnay, of crystals under the main

divisions of the different crystal systems. Within each system, the compounds are listed in order of axial ratio; for each the name, formula, unit-cell dimensions, structure type, specific gravity, and at least one reference are recorded. The list is extremely useful for reference—to find quickly whether a particular crystalline species has been examined at all and how much is known about it. It can also easily be used for identification whenever (still a rather serious limitation) the compound investigated is included in it. But for this particular end, it might be better in future to adopt a different form of listing, for example, in order of length of unit-cell dimensions. One might then hope occasionally to effect identifications with fewer precise measurements—and the actual size of a unit cell is itself often a considerable clue to the nature of the compound present. (Incidentally, thymonucleic acid could not be cubic, $a = 3{\cdot}35$, as in this list, even if Astbury and Bell said so—which they did not.) One cannot, of course, really confuse hæmoglobin, with cell dimensions 76·6, 56 and 49 A., with lead monoxide hydrate, 6·36, 4·65 and 5·93 A., although $a : b$ is 1·367 and 1·368, respectively. But one cannot help feeling that a classification would be more natural which placed them farther apart.

Clearly the authors have done a great service to all those who need to use crystal data for widely varying practical purposes, by collecting together so much material in so comparatively brief and coherent a fashion. The labour of sorting so much information from the literature and then recalculating and reassigning lattice dimensions and axial ratios must have been enormous. But if the authors do turn now—as one hopes they will—to making a real handbook of crystallography, they should surely build it up on different principles. No single classification can bring out all the relations one would like to see made clear. But certainly some serious rethinking of crystal chemical forms of classification is now most urgent and desirable.

DOROTHY HODGKIN

THE LAW AND MERCHANDISE MARKS

The Law of Merchandise Marks, including the Merchandise Marks Act, 1953

By The Hon. H. Fletcher Moulton and P. G. Langdon-Davies. (Reprinted from Butterworths Annotated Legislation Service.) Pp. 170. (London: Butterworth and Co. (Publishers), Ltd., 1954.) 17*s.* 6*d.* net.

THE authors of this small but concisely written book, the Hon. H. Fletcher Moulton and Mr. P. G. Langdon-Davies, are to be congratulated upon producing within a small compass such an admirable and useful summary of the Merchandise Marks Acts. Many judges have deprecated the obscurity and complexity of the language in these Acts concerning, as they do, so closely the welfare of members of the public and having to be administered by lay justices. But the authors have by careful paragraphing with many sub-headings, and a good index, produced a book which is bound to be of great value to business men, as well as lawyers.

As the authors point out, there has always been a reluctance on the part of governments to pass legislation affecting trade. 'Caveat emptor' has persisted as the motto of the jurist, and 'laisser-faire' has largely controlled the methods of the legislator in regard to the trade in the mass of goods which are the subject of advertising slogans. The protection of the consumer does not seem to be an issue over which members of the public or political parties themselves show much enthusiasm. Yet various ways of bamboozling the consumer are rampant and widespread at the present time.

The Merchandise Marks Act 1953, which came into operation in January 1954, has widened somewhat the scope of the Merchandise Marks Act of 1887, which is the principal Act on which all subsequent ones have been grafted. It does little, however, to remove the uncertainties and obscurities of the earlier Acts, which are most difficult to construe. This is particularly unfortunate when so much of the initial work relating to prosecutions under these Acts is dealt with before lay justices. However, the 1953 Act does extend the definition of the terms 'trade description' and 'false trade description'. 'Trade description' now covers statements as to the quality of goods according to a standard used or recognized in the trade or as to the fitness for purpose, strength performance or behaviour of the goods in question. The term 'false trade description' has been amended so as to include a trade description which is misleading in a material respect as regards the goods to which it is applied. These extensions will probably have far-reaching effects.

A short while ago one of the first prosecutions under the new Merchandise Marks Act relating to a trade description which was misleading received considerable publicity at Bournemouth, when a shopkeeper was fined £50 for selling sheets described as "top quality flannelette" when they were nothing of the kind. The addition of the new class of description that has been included by the 1953 Merchandise Marks Act, namely, "as to the fitness for purpose strength performance or behaviour of any goods" (Section 1 (*ab*)), is probably from the practical point of view the most important change made by that Act. There are a number of words and phrases which have been particularly common in modern commerce and the use of which hitherto it has not been possible to stop. Such words or phrases claiming that goods are 'unbreakable', 'unshrinkable', 'mothproof', 'rustless', 'waterproof', 'doesn't damage delicate fabrics', to name a few, now become trade descriptions within the meaning of the Act. If they are misleading in a material respect as regards the goods to which they are applied, then the persons or firms manufacturing or marketing the goods can be prosecuted under the Merchandise Marks Act.

These prosecutions can be undertaken by government departments such as the Board of Trade and the Ministry of Agriculture in certain cases, by local authorities in cases which affect the inhabitants of their area, and by the laying of information at petty sessional divisions in accordance with the procedure applicable to magistrates' courts. The vast majority of prosecutions have been dealt with summarily in magistrates' courts.

The details of the procedures to be adopted, the nature of the issues likely to arise, and summaries of leading cases decided by the courts are all clearly set out in this book. It is to be hoped that it will make a valuable contribution in assisting those persons who are willing to help in clearing away the misleading advertisements and practices arising in trade.

R. G. LLOYD

Journal of the Institute of Metals

Volume 81. 1952–53. Edited by N. B. Vaughan. Pp. xvi+768+106 plates. (London: Institute of Metals, 1953.) 60*s*.

THE Institute of Metals is concerned with theoretical structural metallurgy and the metallurgy of the non-ferrous metals, excluding extractive considerations, and the present volume of its *Journal* contains a representative selection of papers (and discussion). Numerous papers deal with alloy constitution, deformation and behaviour under stress, but also covered are subjects such as viscosity and surface tension, grain refinement of cast metal, metallographic techniques, solid transformations, corrosion and oxidation of metals. In addition, a symposium is included on the control of quality in the melting and casting of ingots for working.

The majority of the papers describe the results of first-class experimental work. They are well written in a concise manner. They are carefully sub-titled, so that coupled with the provision of good synopses, it is easy for the reader to find quickly the information desired.

The format of the *Journal* is of the highest standard. The photographic reproductions are of fine quality, although it is a pity that, in the interests of economy, they are grouped together in what constitutes each monthly issue. The line-drawings are well made and carefully standardized. In all, the *Journal* represents a praiseworthy achievement. A. R. Bailey

Radioisotope Conference 1954

Sponsored by the Atomic Energy Research Establishment, Harwell. Proceedings of the Second Conference, Oxford, 19–23 July. Edited by J. E. Johnston, with the assistance of R. A. Faires and R. J. Millett. Vol. 1: Medical and Physiological Applications. Pp. xi+418. 65*s*. Vol. 2: Physical Sciences and Industrial Applications. Pp. ix+223. 45*s*. Set of two volumes 100*s*. (London: Butterworths Scientific Publications, 1954.)

THE editors and publishers are to be congratulated on producing this report of the second Oxford Radioisotope Conference within a comparatively short time after the meetings. The magnitude of this task is indicated by the fact that some seventy papers on a very wide variety of subjects are reproduced in full, together with verbatim accounts of the discussions following each paper. Perhaps the most striking feature of these two volumes is the distribution of the subject-matter over the various scientific fields. Of the seventy papers, forty-six are concerned with medical and physiological applications of radioactive isotopes, while the remaining twenty-four are spread over various branches of chemistry, physics, metallurgy and industry. If these figures give a true picture of the distribution of uses of isotopes, there is an implication of a regrettable slowness in making use of these new scientific tools over a wide range of applied science.

As pointed out by Sir John Cockcroft in his opening speech, this was not a specialist conference but rather one designed to discuss and spread the knowledge of radioisotopes as tools of research. This outlook is demonstrated in the published papers, where the emphasis throughout is on techniques and where experimental results are used largely to illustrate advances in technique. An attempt has been made to divide the papers under subject headings, and from the point of view of the main purpose of the Conference, this may not be considered entirely satisfactory. It results, for example, in related techniques being found in widely separated parts of the books. This is, however, a minor defect and does not detract from the value of this report as a most important addition to the literature on radioisotopes. In such a rapidly expanding field, it seems certain that further conferences and reports will be needed.

J. E. R.

The Birds of Ireland

An Account of the Distribution, Migrations and Habits as Observed in Ireland. By P. G. Kennedy, *S.J.*, Robert F. Ruttledge and C. F. Scroope, assisted by G. R. Humphreys. Pp. xv+437+11 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1954.) 42*s*. net.

ALTHOUGH books on birds in general are legion, those on the ornithology of Ireland are by no means numerous; indeed, no comprehensive work has been published since that of Ussher and Warren in 1900. During this time many changes have taken place in the status of a variety of species. Some have been lost and some gained. In the present volume P. G. Kennedy, R. F. Ruttledge, C. F. Scroope and G. R. Humphreys have endeavoured to supply this want and deal with the "Birds of Ireland" as they are to-day.

Taking them species by species, they describe the position of each, often having much to say concerning fluctuation of numbers and alteration of status. For example, of the red-necked phalarope they write: "In 1900 two or three pairs were noticed during the breeding season in a marsh in Co. Mayo, and two summers later breeding was definitely established. Since 1902 a colony has bred there with varying success. It seems to have reached its greatest strength in 1905, when about fifty pairs were found. . . . In 1932 Mr. P. E. Dunn and the writer could count only twenty-five birds". They go on to recount the gradual decline of this and neighbouring colonies, pointing out that some of the blame must go to the collectors who took heavy toll of the eggs; but the destruction of nests and eggs by cattle must not be overlooked. Their summing-up of the present position of this phalarope in Ireland is "summer visitor in small numbers and very local. Has decreased rapidly. Extremely rare as an autumn migrant". Frances Pitt

Reports on the Progress of Applied Chemistry

Vol. 37, 1952; pp. 983. Vol. 38, 1953; pp. 989. (London: Society of Chemical Industry, 1954.) 60*s*. each vol. (40*s*. to members).

THE excellent survey of applied chemistry provided by these annual reports is familiar to chemists, and no general description of their contents should be necessary. It may, however, be useful to mention that they are likely to be serviceable in a wider field. In the present volumes, for example, there are sections on agriculture and horticulture dealing with pest control, which should interest botanists; there are also sections on medicinal substances and antibiotics, which will be useful to those interested in medicine.

The general fields of applied chemistry are admirably covered. In view of the very wide range of literature used by the reporters, the volumes, which have author and subject indexes, give a comprehensive survey of all branches of applied chemistry and are indispensable in any chemical library.

JAMES ALFRED EWING (1855–1935)

By E. J. HOLMGREN
Engineering Laboratory, Cambridge

IN an age where extreme specialization in engineering is the rule rather than the exception, it is not always easy to realize that it was usual for engineers to be what might be broadly termed 'general engineers', that is, being equipped with a mixture of the major branches of engineering that was expected to serve them through their professional career. Many of the great engineers of the nineteenth century were such men, and perhaps the last of these was Sir Alfred Ewing, the centenary of whose birth occurred last month. But in Ewing's instance, his training served him for more than merely his professional career; it served him in his scientific researches and in his capacity as a teacher, for perhaps few men have had such a far-reaching effect on British engineering education.

James Alfred Ewing was born in Dundee on March 27, 1855, and received his early education at two of the schools of that city—the West End Academy and the High School. Following this, he won a scholarship of the value of £40 per annum which enabled him to enter the University of Edinburgh, where he studied engineering under Fleeming Jenkin—a man who later exercised a great influence on his life. Jenkin was at the time engaged on research on submarine cables, under the direction of Lord Kelvin, and on his recommendation Ewing spent his summer vacations at Greenwich working on problems in this field. During 1874–76 he made three voyages to South America in connexion with this work, and on his return to Edinburgh completed his B.Sc. degree in engineering.

At the suggestion of Jenkin, Ewing accepted, in 1878, the offer to go to Tokyo as professor of mechanical engineering in the newly established university there. For the five years that he was in Tokyo he organized the chair and carried out researches on the measurements of earthquake movements, designing instruments for this. 1883 found him back in Britain, this time at Dundee, where he was professor of engineering at the then recently founded University College.

Ewing remained at Dundee until 1890, in which year he was appointed professor of mechanical sciences at Cambridge—an appointment which, unknown to him, was to have far-reaching results. At this time, however, the course in mechanism, as it was then known, had fallen into some disfavour, and the Senate would have been glad to drop the whole matter; but this was not possible. Under Ewing, the chair was completely reorganized, the course of instruction laid down, the Tripos established in 1892, and considerable extensions made to the laboratory buildings. While at Cambridge, Ewing carried out researches on the structure of metals, hysteresis, and designed instruments such as a permeability bridge and extensometer.

In 1903 Ewing was appointed director of naval education in Britain, and in this capacity he superintended the complete reorganization on engineering lines of the training of officers. In 1914, with the outbreak of the First World War, this came to an end, and Ewing was then in charge of "Room 40"—a department of the Admiralty entrusted with the decoding of enemy cyphers.

The association with the Admiralty came to an end in 1917, when Ewing was appointed vice-chancellor and principal of the University of Edinburgh. During his tenure of office there, thirteen new chairs were established, new buildings erected and the whole institution organized on modern lines. This vice-chancellorship may be said to be the climax of Ewing's active career. In 1929 he retired to Cambridge, where he spent his remaining years taking an active part in research bodies and learned societies and writing. He died on January 7, 1935.

In assessing the work of Ewing, it is seen that his greatest accomplishments lay in the founding of three engineering schools. It was his pioneer spirit that took him to Tokyo and it was his foresight and administrative ability that laid the foundation for the chair of mechanical sciences at Cambridge, for had a lesser man than he been appointed the development of engineering at Cambridge might have been delayed by many years, and certainly not have reached its present stature; however, it is not wise to speculate in such instances. It is to his everlasting credit that engineering at Cambridge has attained the high standard that it now holds. It was the experience gained from Tokyo, Dundee and Cambridge that stood him in good stead as vice-chancellor of the University of Edinburgh and enabled him to guide it to the eminent place that it holds among British universities.

The task with the Navy had educational features common with his work at the universities, in that the course of training was organized on engineering lines. This change might have been viewed with scepticism by some at the time; but at the Admiralty, men such as Lord Fisher realized the need for such a course, which was to serve the Navy well in two world wars.

The final years of Ewing's life might be said to be a period of retrospect, in which, in his addresses to learned societies, he looked back over the past progress of science, its developments, and its future implications for mankind. Delivering for the second time the James Forrest Lecture in 1928, Ewing voiced the thought that, although engineers had brought great benefits to humanity, they had at the same time created a great potential for ruin. To the British Association he posed the question, was science explaining to the layman that broad outlook it possessed in spite of specialization. He sounded a warning here that perhaps the effect of great discoveries was not altogether beneficial, since man was not altogether prepared for the bounty that Nature had bestowed upon him, for, although he commanded Nature, he did not seem to be able to command himself—a warning which has its significance to-day.

Ewing was the recipient of many honours, among them the Royal Medal of the Royal Society, awarded to him in 1895 for his researches in magnetism. In 1907 he was made a C.B., in 1911 a K.C.B. He was awarded honorary degrees by the Universities of Cambridge, Oxford, Durham and St. Andrews, and held executive positions in many learned societies.

Ewing was the author of many papers on scientific subjects as well as several books, such as "The Steam Engine and Other Heat Engines", now regarded as

a classic, "Strength of Materials", "The Mechanical Production of Cold", and "Thermodynamics for Engineers", the last of which he was writing at the time of his death and which is still read to-day.

Ewing is remembered by those who knew him as a fine lecturer and a teacher who took a great interest in the work of students whom he taught, and as a scientist, in the work of those with whom he worked. To the end of his life he continued to maintain his interest in engineering research and education, and it is perhaps significant that his most fitting memorial is the James Alfred Ewing Medal, awarded by the Institution of Civil Engineers for noteworthy contributions to engineering science. Established in 1936 and first awarded in 1938, it remains to-day as a living monument to one who was scientist, engineer and educator.

ALCOHOL IN THE DIET

VARIOUS aspects of the advantages and disadvantages of alcohol as a dietary constituent were discussed at a symposium of the Nutrition Society on "Alcohol and its Nutritional Significance", held on March 12 in the Wright-Fleming Institute of St. Mary's Hospital Medical School, London, under the chairmanship of Dr. H. E. Magee.

The extent to which alcohol is consumed varies widely, and Prof. E. M. Jellinek showed how misleading gross *per capita* figures can be unless they are broken down into their component details. For example, children make a negligible contribution to the alcohol consumption of a population, and must be allowed for accordingly. A theoretical maximum individual intake of alcohol can be postulated above which it cannot be metabolized and would therefore accumulate; on the commonly accepted figure of 100 mgm./kgm. body-weight per hour, this limit would be about 170 gm. per day. However, there is considerable variation in the rate at which different individuals metabolize alcohol. The frequency distribution of the rates is rather more flat-topped than a normal curve, and rates between 60 and 150 mgm./kgm./hr. are all common. With a high rate of metabolism in a heavy man, a total consumption of up to 400 gm. per day is not to be ruled out as impossible. After excluding children and perhaps impossible figures, it is necessary also to allow for abstainers and for alcoholics. Information from different sources about the incidence of abstainers in the United States are in good agreement, and the number of alcoholics is well known. For the rest of the population, it appears that men drink about three times as much as women, and on this basis the average alcohol consumption of adult Americans who are not abstainers or alcoholics can be estimated at about 46 gm./day for males and 15 gm./day for females. For the alcoholics, of whom there are about a million in the United States, the daily consumption is about 225 gm./day, so that these 8 per cent of all consumers account for about one-third of all the consumption of alcohol in the United States. The details differ, but similar pictures can be presented for other nations. It follows that, in general, alcohol makes a negligible contribution to a national calorie budget but that, when the figures are broken down, the contribution is appreciable at some levels as well as being serious as an interfering factor in overall nutrition at high levels.

The utilization of ingested alcohol was discussed by Dr. J. Tremolieres, who reported particularly the work of Dr. E. Le Breton and Dr. L. Dontcheff. By administration of alcohol to rats and then killing the rats and estimating the amount of unoxidized alcohol in the tissues, it is possible to measure the rate of consumption: in rats this rate is surprisingly constant, and agrees well with determinations based on the rate of decline of the concentration of alcohol in the plasma. The rate of metabolism of alcohol does not depend on the dose of alcohol, and the rate is also unaffected in homoiothermic animals by altering the environmental temperature or by muscular activity. On the other hand, in starvation the rate of utilization is decreased, and the rate can be increased by administering insulin. From experiments with alcohol labelled with isotopic carbon, it appears that metabolic products of alcohol are utilized in the synthesis of fat.

Among the consequences of ingesting alcohol are a sense of well-being, impaired self-criticism and impaired performance of many kinds of skilled action. The other pharmacological actions of moderate doses of alcohol, such as vasodilatation, diuresis and impaired sexual efficiency, are of less practical importance, and Dr. M. Weatherall concentrated on the immediate consequences of including alcohol in the diet, apart from its possible nutritional value. Loss of skill is important when complicated and potentially dangerous actions are performed under the influence of alcohol, and it is useful to assess how much alcohol can be consumed before detectable loss of efficiency occurs. One of the skilled actions most commonly performed under the influence of alcohol is driving motor vehicles, and evidence is available showing that alcohol contributes substantially to the incidence of road accidents. Laboratory studies do not localize the effects of alcohol to any particular part or function of the nervous system, but they permit estimation of threshold quantities for the impairment of various functions; and such studies generally indicate that loss of efficiency begins at about 0·04–0·06 per cent of alcohol in the blood. From such figures it follows that it is unwise to drive a car shortly after consuming more than a pint of beer on an empty stomach. Apart from impairment of skilled actions, there do not appear to be other objections to the consumption of small amounts of alcohol, and there is good evidence that in the long run moderate consumption of alcohol is associated with a greater expectation of life than that enjoyed by total abstainers.

The afternoon session was more directly concerned with nutritional aspects of the use of alcohol. Dr. H. M. Sinclair examined two questions: Does vitamin deficiency predispose to alcoholism? And does alcoholism predispose to vitamin deficiency? Evidence on the first point is unconvincing. When rats have a choice between drinking water and drinking dilute alcohol, they usually choose water if their diet is adequate in calories and alcohol if it is inadequate. On diets deficient in vitamin B_1 they commonly choose alcohol; but on such a diet their calorie intake is usually also inadequate because their appetite is poor, and so their choice of alcohol is not significant. Moreover, in alcoholic humans extensive dietary supplementation with vitamins usually has no effect on the intake of alcohol. On the other hand, vitamin deficiencies are well known as a sequel to alcohol consumption. Alcohol has an acute effect on vitamin A mobilization from the liver

and it impairs dark adaptation. Chronically, effects depend partly on the form in which alcohol is taken: spirits generally yield very little other nutritive matter, whereas a pint of beer provides a substantial fraction of the daily requirement of niacin and appreciable amounts of other vitamins. The typical disorders resulting from excessive consumption of alcohol are fatty infiltration and cirrhosis of the liver, depending on an increased requirement for choline; Wernicke's encephalopathy, due to lack of thiamine and reversible by treatment with it; and peripheral neuropathy perhaps due to the same cause. On the other hand, Korsakow's psychosis appears not to be due to a deficiency of vitamins.

Prof. B. S. Platt was prevented by illness from giving his communication in person; but it was ably presented on his behalf by Dr. C. R. C. Heard. Among indigenous African communities, five kinds of alcoholic beverage are commonly used. They are obtained by the fermentation of honey water, fruit juices, palm sap, milk and grain respectively: fermented palm juice and beer appear to be the most common. These drinks usually contain not more than 5 per cent of alcohol and often less, and they are valuable for their accessory nutritional values, such as nicotinic acid and riboflavin. They are also sometimes preferable to water for human consumption because they avoid the risks of water-borne infections. They are important socially because the ability to provide such drinks is regarded in the community as evidence of social status, and members of a community who fail to offer alcoholic hospitality become outcast. These drinks are valuable also as an interruption of the monotony of life, and they are used in the promotion of co-operative labour in the shape of beer working parties which perform various kinds of agricultural labour that are more effectively carried out communally. The nutritional consequences of the use of these beers therefore include the improvement in feeding which results from the extra food grown by means of such working parties. It is sometimes felt that considerable losses of nourishment occur when grain is converted into beer, but in fact the change in calorie value is very small, and substantial increments in accessory factors are obtained as a result of microbiological activity. On the whole, the use of these native drinks is to be encouraged rather than regretted; but this does not apply to some of the more sophisticated drinks which have been obtained, for example, by the fermentation of golden syrup and subsequent distillation of the products, or from purchased imported gin.

The use of alcohol administered intravenously as a food in patients who are unable to take nourishment by mouth was discussed by Mr. A. W. Wilkinson. For such patients, probably requiring 2,100 calories a day, or more if much tissue catabolism is occurring, unsupplemented intravenous glucose has to be given in enormous volumes or undesirable concentrations in order to provide for their needs. Unsupplemented protein hydrolysates are valuable, but inefficiently utilized unless sufficient carbohydrate is given with them. Solutions of 6 per cent alcohol can be administered without worse effects than making patients drowsy, and can provide up to a thousand or more calories daily. Better results can be obtained by combining alcohol with a sugar and with amino-acids. Fructose is preferable to glucose because it accelerates the oxidation of alcohol, and a solution of 10 per cent fructose, 5 per cent amino-acids and 6 per cent alcohol provides 911 calories per litre. Up to fifty or sixty litres of such solutions have been given to patients over periods of weeks, and they are therefore reasonably safe provided that they are not used when intracranial pressure is raised or in patients with head injuries.

Discussion both in the morning and afternoon was concerned particularly with the metabolic fate of alcohol, and it was generally agreed that the limiting factor in the rate of utilization of alcohol is the rate at which it is oxidized to acetaldehyde, a process probably occurring mainly in the liver. The next stage, oxidation to acetate, provides material which can be used for many physiological syntheses, but the fate of the acetate probably depends on the site at which it is formed. This aspect of alcohol metabolism requires further study, preferably with molecules isotopically labelled at as many points as possible. The inhibition by disulphiram of the oxidation of acetaldehyde to acetate was mentioned, and it was suggested that some of the chronic toxic effects associated with alcoholism may be due to the acetaldehyde formed from it. Tolerance to alcohol depends largely on the rate at which alcohol dehydrogenase operates, and there are substantial individual differences in the activity of this enzyme, possibly partly innate and partly acquired. Much interest was shown also in the nutritive value of other ingredients of alcoholic liquids, and on this score at least it appeared to be generally agreed at the symposium that beer is best.

M. WEATHERALL

NEW SOLUBLE NITROGEN COMPOUNDS (AMINO- AND IMINO-ACIDS AND AMIDES) IN PLANTS

By DR. N. GROBBELAAR, JOHN K. POLLARD and PROF. F. C. STEWARD

Department of Botany, Cornell University, Ithaca, New York

THE familiar but salient dates in the history of the simpler nitrogen compounds to be found in plants tell the story of knowledge slowly, but inevitably, unfolding. From the recognition of the amino-acid character of cystine in 1810, the early recognition of asparagine as a widespread constituent of plants (1806), not chemically identified until 1862, the discovery of glutamine in 1883, through the classical investigations of Schulze (1877–1910) and his pupil Prianischnikow (1895–1910) the march of progress is sure and sedate. Within the present century it came to be tacitly admitted that any of, or all, the amino-acids of protein hydrolysates could occur in the free state in plants, though their recognition and isolation might well presuppose the use of plants or organs in which some particular substance is present in unusual or predominating amounts. In the frequently cited paper of 1906, Schulze recognized the free occurrence of the following ten amino-acids in plants: lysine, arginine, proline, valine, leucine, *iso*leucine, phenylalanine, tyrosine, tryptophan and histidine. Some obvious omissions from this list were amino-acids then known as constituents of protein but the existence of which free in plants was only recognized at a later date (for example, aspartic and glutamic

acids, which when first seen were thought to be decomposition products of amides, cystine, glycine, alanine and serine). Between 1906 and 1947 a few amino-acids were newly discovered, of which methionine and threonine occurred in protein, whereas others, namely, dihydroxyphenylalanine, citrulline, canavanine, djenkolic acid and β-alanine were known to occur only in the free state.

From the first use of two-directional paper chromatography[1] in the examination of the alcohol-soluble constituents of plants, it became clear that the ninhydrin-reactive constituents far outnumber the readily recognizable constituents of protein hydrolysates. The dramatic effect of such work is only realized when the relatively simple nature of many of these compounds is appreciated and when their occurrence, often in quantity, in familiar plants is recognized. γ-Aminobutyric acid, piperidine-2-carboxylic acid, γ-methyleneglutamine, γ-methyleneglutamic acid and homoserine, to mention but a few well-chosen examples, soon became recognized as substances that occur free in plants, though their identity had passed hitherto unnoticed in the plants in which they occur. Every succeeding summary of this field of knowledge adds to the list of substances identified and also to the list of substances detected but unidentified[2,3].

In these circumstances, progress is not only rapid but also priorities to discoveries become difficult to establish, for, with similar lines of work being pursued in various laboratories, the ordinary channels of scientific communication become too slow and the personal letter, speeded on its way by air mail, again comes into its own as an instrument of scientific communication. The further purpose of this paper is to illustrate this point and make reference to two examples of recent discovery which have developed even as the last summary[3] in this field was being written. The two examples in question concern the free occurrence of certain piperidine carboxylic acids in plants and also of certain derivatives of glutamic acid. While these subjects have in general engaged the attention of our laboratory for some time, it is proper to record that the recent events, here described, have developed around the work of one of us (N. G.) on piperidine carboxylic acids and of another (J. K. P.) on the glutamic acid derivatives.

Cyclic Imino-Acids

Pipecolic acid (piperidine-2-carboxylic acid) was one of the first substances to appear on paper chromatograms of plant extracts as an unidentified, but easily recognizable, spot (unknown No. 1, see Steward and Thompson[2] and Zacharius[15]). It was later isolated and identified from plants almost simultaneously in different laboratories[4–6], and it is now recognized as a substance that is frequently found in legumes[7,8], from which it may be isolated in comparatively large quantities[9]. Moreover, the biogenesis of this substance from lysine has been established[10–13].

In this laboratory a key step in the identification of the naturally occurring L(−)-pipecolic acid consisted of proving its identity with a product obtained on reducing a substance, baikiain, identified[14] after isolation from the wood of a leguminous tree (*Baikiaea plurijuga*). The occurrence of pipecolic acid in the fruit and seed of the green bean (*Phaseolus vulgaris*) and the ready formation of pipecolic acid from lysine in the developing seed[10] encouraged one of us (N. G.) to examine the seed of the plant *Baikiaea plurijuga*

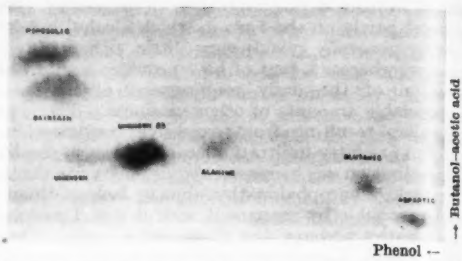


Fig. 1. Alcoholic solution of nitrogen compounds of seed of *Baikiaea plurijuga*

(Rhodesian teak). A paper chromatogram (Fig. 1) of an alcoholic extract of these seeds clearly showed, among other things, the presence of substances each having characteristic properties, as shown in Table 1.

The chromatographic characteristics of unknown No. 83 (Fig. 1) were very similar to that of a substance (unknown No. 39) previously noted in this laboratory by Zacharius[15] in the seed of the honey locust (*Gleditschia trichanthos*).

From this point the substance designated above as unknown No. 83 was rapidly isolated in a state of chemical purity from the seed of *Baikiaea*. The main steps in the isolation from a 70 per cent alcoholic extract of the seed were as follows. The extract was evaporated to a syrup, hydrolysed for two hours at 120° C. in 6 *N* hydrochloric acid, the bulky precipitate that formed during hydrolysis was filtered off and the filtrate freed of excess hydrochloric acid by evaporation. The residue from the filtrate was dissolved in water and passed down a column containing a cation exchange resin ('Zeorex') in the H+ form. The adsorbed unknown No. 83 was displaced with ammonia, and the eluate containing several amino-acids, in addition to unknown No. 83, was freed of ammonia by concentration under reduced pressure. The amino-acids of the concentrate were fractionated by chromatography in water on a column of 'Amberlite *XE*-64', a poly-carboxylic cation exchanger in the H^+ form. The fractions richest in unknown No. 83 were decolorized on the weakly basic 'Amberlite *IR*-45' ion exchange resin which was in the OH^- form. Unknown No. 83 was crystallized from the concentrated solution by the addition of ethanol. After two additional recrystallizations of the isolate from water by the addition of alcohol, 300 mgm. of a chromatographically pure product was obtained in the form of its free base. The compound, which does not appear to have a definite melting point, begins to decompose

Table 1

	Baikiain	Pipecolic acid	Unknown No. 83
Rf in phenol saturated with water (*p*H 5·5)	0·878	0·895	0·744
Rf in *n*-butanol : acetic acid : water (9 : 1 : 2·5 v/v)	0·178	0·214	0·113
Rf in collidine : lutidine (1 : 3 v/v) saturated with water	0·254	0·384	0·374
Fresh ninhydrin colour	yellow-yellow	red-violet	red-violet
Ninhydrin colour after 12–24 hr.		yellow-brown	yellow-brown
Fluorescence in ultra-violet light of the freshly prepared ninhydrin product	none	crimson	crimson
Colour with isatin	yellow-brown	blue-green	blue-green
Concentration (mgm./gm. of seed)	24·0	3·0	3·0

at 265° C. Its specific optical rotation was found to be $[\alpha]_D^{H_2O} = -12{\cdot}5°$.

The various properties of this substance, its reaction with isatin and its general chromatographic behaviour[16] were compatible with its identity as a hydroxypipecolic acid, a substance the natural occurrence of which as a derivative of hydroxylysine could almost be predicted by analogy with the biogenesis of pipecolic acid from lysine. The analysis of the isolated compound :

	C	H	N	O
Isolate (free base)	49·74	7·76	9·74	32·96
Calculated for $C_6H_{11}O_3N$ (hydroxypipecolic acid)	49·64	7·64	9·65	33·07

was compatible with this identification, and an infra-red absorption spectrum, obtained with the potassium bromide disk method, showed features that were compatible with its identity as one of the possible hydroxypiperidine carboxylic acids.

At this point one of us (F. C. S.) received from Prof. A. I. Virtanen, of Helsinki, Finland, a letter, dated August 6, 1954, in which he mentioned that 5-hydroxypipecolic acid had been isolated from a plant in his laboratory. An immediate request for the name of the plant from which this isolation had been made produced a response, dated September 15, 1954, indicating that the substance had been isolated from a palm, *Rhapis excelsa* (*Rhapis excelsa*, Thunb., Henry, is referred to by Prof. Virtanen and by Virtanen and Kari[17] by the older name, *Rhapis flabelliformis*, Ait.). Thereafter, it was only a matter of hours before an extract was made to show that the leaves of *Rhapis excelsa* from the Cornell greenhouses contained the substance referred to by Virtanen as 5-hydroxypipecolic acid and that this substance was identical with the one isolated from *Baikiaea* seeds with respect to chromatographic position and colour reactions. A further request to Prof. Virtanen was promptly answered (letter dated September 23, 1954) and a few milligrams of his isolate (in the form of the hydrochloride), now isolated from the legume *Ceratonia siliqua*, was made available. With this, the chemical identity of the substance isolated from *Baikiaea* by one of us (N. G.) and the substance isolated from *Rhapis* and *Ceratonia* was established beyond all doubt by means of their infra-red absorption spectra shown in Fig. 2.

Our own desire to establish the position of the OH group in the piperidine ring had led to a request

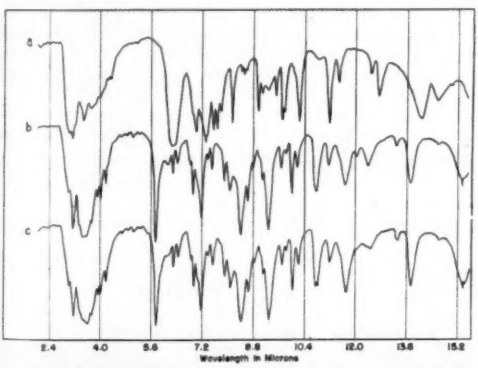


Fig. 2. The infra-red absorption spectra of 5-hydroxypipecolic acid. *a*, isolate (unknown No. 83) from *Baikiaea* (free base); *b*, isolate (unknown No. 83), from *Baikiaea* (hydrochloride); *c*, isolate from *Ceratonia* (hydrochloride from Prof. A. I. Virtanen)

to Prof. F. E. King, of the University of Nottingham, who had previously aided us in the identification of pipecolic acid, for a sample of the 5-hydroxypipecolic acid that he had prepared synthetically[14]. This elicited the prompt reply that Prof. Virtanen had already used this material to establish the identity of the substance he had isolated from *Rhapis*, etc. Parenthetically, Prof. King commented that the hydroxypipecolic acid had undergone some decomposition since its preparation.) Nevertheless, the identification of this new imino-acid from plants now depends on the work from Prof. Virtanen's laboratory. They state that under certain conditions of oxidation their isolate yields both aspartic and glutamic acids and they rely mainly on this evidence in identifying the new compound as 5-hydroxy-piperidine-2-carboxylic acid[17]. The identity of the material isolated in this laboratory with that of Prof. Virtanen's sample is established by the evidence which we have cited above.

It should be noted, however, that the possibilities of isomerism in the monohydroxypiperidine carboxylic acids, each with two asymmetric carbon atoms, are numerous, and it may well turn out to be an interesting question how far these possibilities are exploited in plants. A thorough study of this interesting problem awaits the preparation and resolution of all the possible hydroxypiperidine carboxylic acids.

At this point two further developments occurred. First, the existence of new hydroxy imino-acids from apples was disclosed to us by Dr. A. C. Hulme from England (letter dated February 26, 1954) and by Dr. H. S. McKee in a letter from Australia dated July 9, 1954. These appeared to be isomeric with hydroxypiperidine carboxylic acids. Samples of the isolate obtained from apple leaves in McKee's laboratory[18] in Australia and from apple peel by Hulme[19] in England became available in this laboratory, and infra-red scans showed beyond doubt their identity with each other and their complete distinction from the isomeric hydroxypiperidine carboxylic acids. The fact that the infra-red spectra of these acids from apple are more compatible with the pyrrolidine, rather than the piperidine, ring system, becomes important in view of the isolation of still another substance from *Rhapis*, 4-hydroxy-piperidine-2-carboxylic acid[20], and which Prof. Virtanen was inclined to suggest could be identical with the substance from apples (letter to Dr. Hulme of January 14, 1955). It now seems quite clear that this is not so[21].

Secondly, Gartler and Dobzhansky[22] recently directed attention to the occurrence in certain human urines of a ninhydrin-reactive substance, which they did not attempt to identify, but which they showed was associated with subjects who had eaten dates. These workers found that the unidentified compound, first detected in urine, also occurs in the free state in the pericarp of dates. The chromatographic behaviour of this new compound, as described by Gartler and Dobzhansky, suggested to us that it could be a hydroxypiperidine carboxylic acid. A 70 per cent ethanol extract of the pericarp of edible dates was therefore prepared. The amino-acids of the extract were adsorbed on 'Zeorex' resin and, after washing the resin with water, eluted with ammonia. A chromatogram (Fig. 3) of the partially purified amino-acid fraction clearly showed the presence in the date of baikiain, pipecolic acid and also a considerable amount of 5-hydroxypipecolic acid and even

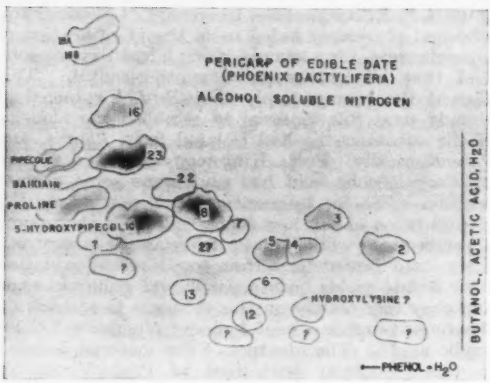


Fig. 3. Nos. follow an earlier convention (refs. 1-3). 2, Aspartic; 3, glutamic; 4, serine; 5, glycine; 6, asparagine; 7, threonine; 8, alanine; 12, lysine; 13, arginine; 16, valine; 18A, *iso*-leucine; 18B, leucine; 22, β-alanine; 23, γ-aminobutyric acid; 27, homoserine

the possible presence of hydroxylysine with which the latter may be biochemically interrelated.

The conclusions then are clear. Not only is piperidine-2-carboxylic acid now to be regarded as of widespread occurrence in plants, derived no doubt from lysine; but other related piperidine carboxylic acids also occur. The only partially unsaturated ones are baikiain and guvacine (the latter has long been known to be a constituent of the betel nut, *Areca catechu*). However, the occurrence of 5-hydroxypipecolic acid, and now the evidence that 4-hydroxypipecolic acid also occurs in Nature, raises numerous questions as to the metabolic role of this family of substances in both plants and animals. It is a striking testimony to the resolving power of modern chromatographic methods that this area of plant biochemistry has been so rapidly uncovered. It is also a striking testimony to the pace of discovery in this field that different laboratories can only keep abreast of this progress by the use of air mail communication.

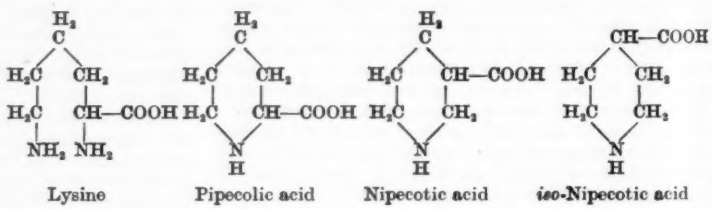
The structural formulæ of the various compounds mentioned above are shown herewith.

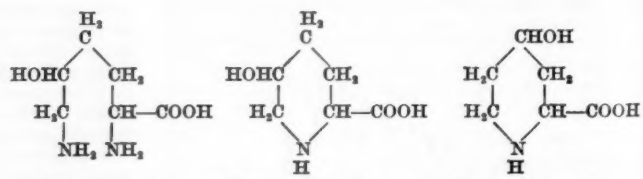
Derivatives of Glutamic Acid

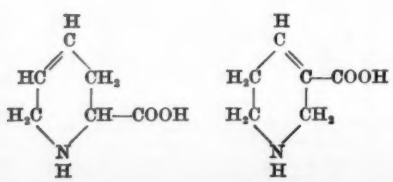
One of the dramatic developments following the application of paper chromatography to the examination of the alcohol-soluble nitrogen of plants was the recognition of a third amide in plants. The chromatographic maps of Steward and Thompson[2] recognized the occurrence of two unidentified substances (Nos. 4 and 12) in the tulip. These were related, one to the other, by acid hydrolysis. Following the discovery of γ-methyleneglutamine in the peanut (*Arachis hypogea*[23]), the substances in the tulip were shown to be identical with this new amide and its acid, respectively[24]. A key point in this work was the use of infra-red methods to compare products obtained from Dr. Fowden, in England, with products isolated from the tulip. With the recognition that the keto acid corresponding to γ-methyleneglutamic acid can also occur[25] and with the existence of a transamination mechanism in which it could be involved[26], this family of substances is rapidly assuming importance in plant biochemistry. As in the case of 5-hydroxypipecolic acid and its related dehydro substance, baikiain, it now appears that a hydroxyl derivative corresponding to γ-methyleneglutamic acid occurs in plants. This substance is γ-methyl, γ-hydroxyglutamic acid, and its first isolation comes, strangely enough, from a fern.

In an examination[27] of the nitrogenous composition of certain shoot apices of plants, carried out jointly by the Cornell and Harvard Laboratories, a curious observation was made. The bulk of the soluble nitrogen in the growing apex of the maiden hair fern (*Adiantum pedatum*) gave a strong spot, which was close to that of serine, on phenol : collidine–lutidine chromatograms. A slight shift in the chromatographic position of this compound, after acid hydrolysis, aroused the suspicion that the product might be a glutamic acid derivative, but the dramatic feature was the total amount of this substance present.

This substance was recently isolated by one of us (J. K. P.), the chief steps in the isolation from an alcoholic extract of leaves of *Adiantum pedatum* being: absorption on 'Amberlite *IR*-45', elution with acetic acid and evaporation to near dryness. The crystals which gradually formed in the concentrate were found to be very insoluble in cold water,

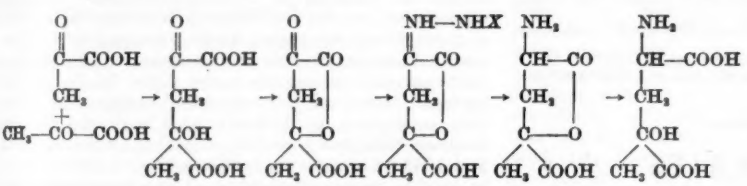






and after recrystallization from aqueous ethanol, 37 mgm. of chromatographically pure product was obtained.

From its chromatographic behaviour the isolate appeared to be a dicarboxylic amino-acid and possibly even a hydroxydicarboxylic amino-acid. The isolate gave the following elementary analysis (percentages): C, 38·59; H, 6·68; N, 7·54; O (by difference), 47·19, which is consistent with $C_6H_{11}O_5N.\frac{1}{2}H_2O$, for which the percentage elementary composition is: C, 38·71; H, 6·45; N, 7·53; O, 47·31. At this point it was learned that γ-hydroxy, α-aminopimelic acid had been obtained from another fern (*Asplenium septentrionale*)[18]. It was clear, from the elementary analysis of the *Adiantum* isolate, that this compound is not γ-hydroxy, α-aminopimelic acid. Additional proof of this was obtained by comparative paper chromatography of the compound isolated from *Adiantum* and γ-hydroxy, α-aminopimelic acid, kindly furnished by Prof. Virtanen. In these circumstances the identity of the isolate from *Adiantum* as a methyl, hydroxyglutamic acid suggested itself, and the conceivable relationship of γ-methyl, γ-hydroxyglutamic acid to γ-methyleneglutamic acid, which only differ by a mole of water, became highly suggestive. The γ-methyl, γ-hydroxyglutamic acid, by way of its lactone, was prepared from a pyruvic acid aldol condensation product prepared by the method of De Jong[20]. (The biogenesis of γ-methyleneglutamic acid from pyruvate by condensation, dehydration and amination was regarded as a possibility from its first recognition.) By forming a hydrazone of the lactone of the pyruvic aldol, and subsequent catalytic hydrogenolysis, the corresponding amino-acid was made[20].



During the synthesis of γ-methyl, γ-hydroxyglutamic acid two centres of asymmetry appear and so there are four possible isomers, two of which are to be distinguished as allo and two as threo forms. An obvious doubleness of the violet ninhydrin spot corresponding to the synthetic free acid could be explained in this way. The lactone, giving a brown colour with ninhydrin, shows only a single spot.

The crystalline isolate from *Adiantum* corresponds to the free acid and agrees in R_F with one of the two synthetic components, and it forms a small amount of the lactone on standing in aqueous solution (Table 2).

Table 2

Compound	R_F values			Ninhydrin colour
	Phenol	Butanol-acetic	Collidine-lutidine	
γ-Methyl, γ-hydroxyglutamic acid*	0·217	0·068	0·197	violet
Lactone of γ-methyl, γ-hydroxyglutamic acid	0·611	0·073	0·415	brown turning olive-grey

* Crystalline isolate from *Adiantum* and one component of the synthetic acid.

While the further characterization of the isolate will require more complete treatment elsewhere, the implications of its tentative identification as γ-methyl, γ-hydroxyglutamic acid can now be discussed. Since the preparation of this manuscript it has been possible to show, by the method of Towers, Thompson and Steward[20], that the keto-analogue, γ-methyl, γ-hydroxy, α-ketoglutaric acid, also occurs free in *Adiantum pedatum*.

The principal soluble nitrogen compound of *Adiantum* (accounting for about 90 per cent of the soluble nitrogen in certain cases) is a new natural substance (γ-methyl, γ-hydroxyglutamic acid) the nearest relative of which would be its dehydration product, γ-methyleneglutamic acid, recently described from the peanut and the tulip. The substance also could be related to methylhydroxyproline[19,21] by a series of feasible reactions analogous to those that lead to the formation of proline from glutamic acid via pyrrolidine carboxylic acid or glutamic γ-semialdehyde[21]. The fact that these unexpected compounds are prominent in such widely separated members of the plant kingdom would seem to indicate that they are part of some quite general feature of plant metabolism. Also the fact that in different genera of ferns two dissimilar hydroxy acids (γ-methyl, γ-hydroxyglutamic and hydroxyaminopimelic acids) have been discovered almost simultaneously emphasizes again the need to explore, by modern techniques, the nitrogen metabolism of a wider range of plants.

The expectation now is that a baffling array of relatively simple compounds may occur free in plants in addition to the amino-acids of protein hydrolysis which, as the great pioneers believed and showed, may also occur free. In these new compounds a straight chain or cyclic structure may be substituted by hydroxyl or alkyl groups, may show saturated or unsaturated conditions, and may present in the mutual relations of the nitrogenous groups and the carboxyl groups a far greater diversity than would have been expected hitherto.

As we have tried to show, the pace of discovery in this field is now so rapid that new observations come so fast as to outpace interpretation. Stimulating as this is, however, it should be followed by the full exploration of all the possibilities. Even though Nature may utilize but a few of the isomers, it should not be forgotten that any full understanding of the possibilities inherent in the isomeric hydroxypiperidine carboxylic acids, the hydroxymethylglutamic acids, or the methylhydroxyprolines, etc., will require much careful work in which the synthetic organic chemist and the plant biochemist should collaborate.

Inasmuch as the plant and its relation to nitrogen is of paramount importance in agriculture, nutrition and biochemistry, there can be few more rewarding areas of research to-day than the investigation of nitrogen metabolism in plants by the methods now available.

This account is based on work made possible through the Grasselli Grant to Cornell University for work being directed by one of us (F. C. S.).

The association of one of us (N. G.) with the work was made possible by a Rockefeller Foundation Fellowship at Cornell University (present address, University of Pretoria, South Africa).

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OBITUARIES

Dr. G. M. Lees, F.R.S.

Dr. George Martin Lees, until recently chief geologist to the Anglo-Iranian Oil Company, died on January 26 at the age of fifty-six. He had a friendly virile personality, boundless vitality and exceptional powers of understanding and constructive thought. He was a strong protagonist of full and early publication of scientific results acquired in commercial exploration, particularly in Britain; his death is a great loss to geological science and to its practical application.

Born on April 16, 1898, the son of George Murray Lees, of Edinburgh, he was educated at St. Andrew's College, Dublin, and proceeded to the Royal Military Academy, Woolwich, whence he was commissioned in the Royal Artillery in 1915; he served in France, winning the M.C., and afterwards he transferred to the Royal Flying Corps. Following a period as flying instructor in Egypt, he saw further service in Iraq, where he won the D.F.C. When hostilities ceased he joined the civil administration of Iraq and was appointed assistant political officer in Southern Kurdistan during a lively period in the history of that province.

Lees's entry to geology came with his accepting in 1921 the offer of a post as assistant geologist with the Anglo-Iranian Oil Co., Ltd., and he set about learning geology in the course of his duties, attending occasional courses at the Royal School of Mines during his leave periods. His first three years as a geologist were spent on fruitful surveys in south-west Persia, for a time in association with H. de Boeckh; in 1925 he undertook a classic survey of Oman, and he secured for the Anglo-Iranian an option on the oil-rights of Qatar from the shaikh of that territory. A year's study leave at the University of Vienna resulted in the award of a Ph.D. for his thesis on the geology of Oman, which brought much new stratigraphical and structural information to its subject. After serving in all countries where exploration by his Company was then practicable, Lees was made chief geologist in 1930. At that time the Anglo-Iranian had but three producing oil-fields in the Middle East; exploitation, however, soon increased, and geological exploration expanded not only there but also in New Guinea, Trinidad and Nigeria, and after the Second World War new ventures were started in Sicily, Switzerland and East Africa. So Lees travelled extensively and developed a wide and intimate geological knowledge of many and varied problems, particularly in the field of structural geology.

Meanwhile, since 1930 and in the face of criticism bordering upon ridicule, Lees had been pressing the directors of the Anglo-Iranian to have a systematic search for oil conducted in Britain, and in this search he took a leading part. Prospecting licences were taken out in 1935 and several borings were drilled; but though useful geological information was obtained, commercial success was not achieved until in 1939, on the basis of a seismic survey, the first well was drilled at Eakring in Nottinghamshire. Further exploration proved the Eakring structure to be one of three closely associated domes arranged in echelon, each with a considerable accumulation of oil in Upper Carboniferous sandstones some 2,000 ft. below the surface. More than a hundred and eighty wells came into production at Eakring, and with the nearby Kelham Hills and Caunton wells first drilled in 1941 and 1943 an annual production of up to 100,000 tons of good oil was reached when oil was most needed for the British war effort. These fields are still in production to-day. Extensive exploration by boring, accompanied by geophysical work, continued in many parts of Britain and resulted in an enormous amount of new and well-documented information concerning the underground geology of the country. These results were communicated to the Geological Society in 1937 and 1944. That Society awarded its Bigsby Medal to Lees in 1943, and some years later elected him as its president; thus he became the first geologist practising his profession in industry to receive this distinction. His presidential addresses on "Foreland Folding" (1952) and "The Evolution of a Shrinking Earth" (1953) dealt with fundamental concepts and were characteristically thoughtful and ingenious. Lees was elected a Fellow of the Royal Society in 1948 and, shortly after his retirement from active service with the Anglo-Iranian Oil Co., early in 1954, the American Association of Petroleum Geologists awarded him the Sidney Powers Memorial Medal.

His remarkable knowledge, shrewdness, good humour and skill of exposition had powerful influence in the counsels of the Anglo-Iranian Oil Co. and those of the learned societies to which he belonged. These same attributes were profitably used by the Boards

of the Geological Survey and of the Colonial Geological Surveys, of which he was a valued member. He married Hilda Frances, daughter of E. B. Andrews, of Birmingham, in 1931, and they had one son.

C. J. STUBBLEFIELD

Dr. C. E. Larard

CHARLES EDWARD LARARD, whose death occurred on September 23, was for many years head of the Department of Civil and Mechanical Engineering in the Northampton Polytechnic, London. He served his apprenticeship at the Vulcan Iron Works, remaining with this firm afterwards for some time as chief draughtsman. His early scientific and technical training took place at the Hull Technical Institute. Later, at the Andersonian College, Glasgow, under Prof. Humboldt Sexton, he studied for an honours course in practical metallurgy, after first taking honours in practical chemistry. He continued his studies at the University of Manchester, and for a short time at the Royal College of Science and Technology, London, where he gained a free studentship and Royal Exhibition: these he resigned in order to obtain specialized instruction elsewhere.

For one year Dr. Larard was lecturer for the Carron Iron Works, Stirlingshire, and for the following four years he held a post as lecturer in the Civil and Mechanical Engineering Department at the Battersea Polytechnic, London. He was then appointed head of the Civil and Mechanical Engineering and Architectural Departments of the Huddersfield Technical College, a post which he held for more than three years; during this time he equipped the Engineering Department and founded the Huddersfield Engineering Society, of which he was the first president.

In 1902, Dr. Larard became head of the Civil and Mechanical Engineering Department of the Northampton Polytechnic, London—a post which he held for thirty-two years, until his retirement in 1934. During this period he was a member of the Board of Studies in Civil and Mechanical Engineering and a member of the Faculty of Engineering in the University of London. He was also a member of the British Standards Institution.

During the First World War, Dr. Larard was director in charge of the workshops at the Northampton Polytechnic, which supplied high-precision gauges and gun parts for the Admiralty, War Office and other government departments, and in addition he carried out work on aeroplane construction on behalf of the Admiralty and the Aeronautical Inspection Department.

Dr. Larard's father, Charles Larard, was also a mechanical engineer, and his own eldest son, Charles Kenneth, a chartered civil engineer, is at present chief engineer to Messrs. Butterfield and Swire in Hong Kong and the Far East.

NEWS and VIEWS

Rockefeller Foundation, New York

THE ROCKEFELLER FOUNDATION, New York, has recently been reorganized so as to bring its various activities into closer relationship with one another. Dr. Alan Gregg continues as vice-president on special assignments, Dr. Lindsley F. Kimball, a vice-president of the Foundation since 1949, is now executive vice-president, and Dr. Warren Weaver has been appointed vice-president for the natural and medical sciences.

The previous organization of the Foundation into divisions has been changed to one in which the responsibility for its programme is placed in the hands of five directors as follows: Dr. Norman S. Buchanan, social sciences; Dr. John C. Bugher, medical education and public health; Dr. Charles B. Fahs, humanities; Dr. J. George Harrar, agriculture; and Dr. Robert S. Morison, biological and medical research. Dr. Buchanan, who will take up his appointment in July, succeeds Dr. Joseph H. Willits, who retired last year; Dr. Buchanan was associate director for social sciences during 1947–50 and is at present professor of economics in the University of California. Dr. Bugher is on leave from the Foundation for four years, serving as director of the Division of Biology and Medicine of the United States Atomic Energy Commission, and by special arrangement will continue on the Commission for a further period; before joining the Foundation in 1951 he had been for five years director of the Yellow Fever Institute in Lagos, Nigeria. Dr. Fahs continues as director in charge of the humanities programme of the Foundation, in which capacity he has served since 1950. Dr. Harrar joined the Foundation in 1943 as local director for the agricultural programme in Mexico and was appointed deputy director for agriculture in 1952. Dr. Morison, who has been assistant and associate director of medical sciences in the Foundation since 1944, was previously teaching in the Departments of Physiology and Anatomy of Harvard Medical School. The three directors concerned specifically with the natural sciences, Drs. Harrar, Morison and Bugher, will be working in co-operation with Dr. Weaver, who, as vice-president for the natural and medical sciences, will be responsible for developing, co-ordinating and supervising all the Foundation's activities in science. Director of natural sciences and agriculture since 1932, Dr. Weaver is a distinguished mathematician and is retiring president and chairman of the board of the American Association for the Advancement of Science.

The reorganization is in keeping with the fact that for a number of years the primary emphasis in the Rockefeller Foundation's programme in the natural sciences has been upon modern experimental biology. But this does not mean that mathematical and physical sciences are being neglected, for a special feature of the biological programme has been to utilize the application of mathematics, physics and chemistry to basic biological problems; occasional grants strictly in the physical sciences have also been made from time to time. As one who has been trained in mathematics and physics, this continuing interest in the physical sciences will be a special responsibility of Dr. Weaver himself.

Royal Meteorological Society: Symons Memorial Gold Medal

THE Symons Memorial Gold Medal of the Royal Meteorological Society, which is awarded biennially for distinguished work in meteorological science, has

been conferred this year on Dr. R. C. Sutcliffe, a deputy chief scientific officer in the Meteorological Office, for his outstanding work in the field of synoptic and dynamical meteorology. The award was made at the annual general meeting of the Society on April 20. The citation stated: "Dr. Sutcliffe's success as a practical weather analyst and forecaster is matched by his achievements as a practical theorist and teacher. To his fundamental researches we owe a great deal of our knowledge of the effect of temperature patterns on development. His two-layer model of atmospheric motion has become the basis of a practical method of numerical weather forecasting. To his ability and enthusiasm is due in large measure the remarkable success of the Napier Shaw Laboratory. His engaging popular style combined with his seriousness of purpose have made him one of the most successful teachers and there can be few meteorologists whose understanding has not been deepened and broadened as a result of his efforts".

Canadian Award in Meteorology: Dr. John Patterson, O.B.E.

In 1947, shortly after Dr. John Patterson's retirement from the post of controller of the Canadian Meteorological Service, a fund was established by donations from his many friends and associates, from which a Patterson Medal is to be awarded annually to a Canadian resident for distinguished service to meteorology. The fund is held in trust by a group of the senior officials in the Canadian Meteorological Service, who will annually appoint an award committee composed of representatives from the Meteorological Service, research institutions, Canadian universities and Canadian industry. The first award of the Medal has recently been made to Dr. Patterson himself. Dr. Patterson, who is eighty-three, was controller of the Canadian Meteorological Service during 1929–46. He graduated from the University of Toronto in 1900, with the gold medal in physics, and was then awarded an 1851 Exhibition Science Research Scholarship which took him to England for two years at the University of Cambridge. He later became professor of physics in the University of Allahabad for two years, after which he was appointed head of the Indian Weather Service. He joined the Canadian Weather Service in 1910. During his association with the Service, Dr. Patterson contributed to the design of a series of instruments especially suited to rugged Canadian weather conditions, and under his guidance the Service expanded rapidly, in keeping with the heavy demands placed upon it by the British Commonwealth Air Training Plan of the Second World War. He is known internationally for his personal interest and leadership in the World Meteorological Organization and other scientific societies.

Upper Atmosphere Research by the National Research Council of Canada

Dr. Peter M. Millman, formerly chief of the Stellar Physics Division of the Dominion Observatory, Canada, has joined the National Research Council of Canada and will work in the Division of Radio and Electrical Engineering, leading the section on upper atmosphere research. Dr. Millman, who was born in Toronto in 1906, graduated from the University of Toronto in 1929, and then took a Ph.D. in astronomy at Harvard University in 1932. During 1933–45 he was on the staff of the David Dunlap Observatory and lecturer in astronomy, University of Toronto, and since then he has worked at the Dominion Observatory, being chief of the Stellar Physics Division since 1951. During 1941–46 he was in the Royal Canadian Air Force, first as a navigation instructor and later in charge of operational research, retiring with the rank of squadron leader. Dr. Millman's investigations for the past twenty years have been concerned mainly with meteors and meteorites; but he has also worked in the field of stellar radial velocities and in the observation of solar eclipses from the air.

Martin Barry (1802–55)

Martin Barry, who died one hundred years ago on April 27, 1855, is an interesting example of an amateur who made valuable contributions to science. Born at Fratton, in Hampshire, on March 28, 1802, he studied medicine in Paris, Erlangen, Berlin, Edinburgh and London, and graduated M.D. of the University of Edinburgh in 1833. In the following year, while on a visit to Switzerland, he climbed Mont Blanc in mid-September—later in the season than any successful attempt previously recorded—and published a paper "On Dyspnœa and other Sensations experienced on the Summit of Mont Blanc" in the *Proceedings of the Royal Society of Edinburgh*. For a year he studied embryology under Friedrich Tiedemann at Heidelberg, and his "Researches in Embryology" (1838–40) won him one of the Royal Medals of the Royal Society in 1839; he was elected a Fellow in 1840. Barry is principally known for two fundamental discoveries: the segmentation of the yolk in the mammiferous ovum obtained from the Fallopian tube, and the penetration of spermatozoa within the zona pellucida of the rabbit's ovum. While the ovum and spermatozoon had each been known for many years, their union in the process of fertilization had so far remained conjectural. Barry observed an orifice in the zona pellucida, its form "suggesting the idea of the membrane having become cleft", and described within it some five hours after coitus, "an object very much resembling a spermatozoon". His findings, doubted at first, were afterwards confirmed by T. L. W. Bischoff and others. Barry was one of the first in 1840 to note proliferation of cells by division of the nucleus and cytoplasm. In 1844 he became house-surgeon to the newly founded Royal Maternity Hospital in Edinburgh; but, his health failing, he returned to the Continent of Europe, where he cultivated his intimate friendship with Johannes Müller, Theodor Schwann, Rudolph Wagner, J. E. Purkinje and G. G. Valentin. In 1853 he settled at Beccles in Suffolk, his sight almost ruined by the strain of microscopic work, and a victim of neuralgia and insomnia. He died at the early age of fifty-three.

Poliomyelitis Vaccine Tests in Great Britain

The Medical Research Council has announced that a limited amount of anti-poliomyelitis vaccine, similar to that used in the United States, will be available to the Council this year and that small groups of children will be vaccinated in a few centres in Great Britain and Northern Ireland, where there are laboratories engaged in studying the poliomyelitis virus. By means of blood tests on the vaccinated children, information on the response to the vaccine will be obtained, and this will be compared with the information obtained from laboratory tests. The results will be used for planning the most effective use of the larger quantities of vaccine which

are likely to become available in Britain in 1956. It is emphasized by the Council that the vaccine is at present available only for these limited purposes, and that applications for inoculation cannot be entertained.

Gravity Survey in the South Atlantic and Indian Oceans

GRAVITY surveys are to be made during a training cruise by H.M. Submarine *Acheron* to Trincomalee via the Cape of Good Hope and back through the Mediterranean. Observations will be made by Lieut. J. C. Harrison, R.N.V.R., a 25-year-old National Service officer who, after taking his degree at Cambridge, went to the University of California. From the coast of California he has recently made some half-dozen cruises in U.S. submarines in the course of which gravity surveys have been made. Three gravity surveys organized by the Department of Geodesy and Geophysics at Cambridge have previously been made in British submarines in Home and Mediterranean waters. They have been organized through the Defence Services Research Facilities Committee of the Royal Society. The forthcoming gravity survey will be in the South Atlantic and Indian Ocean, and it is in response to a resolution of the General Assembly of the International Union of Geodesy and Geophysics requesting all maritime powers to carry out so far as possible soundings and gravity measurements in those of the oceans which have not yet been explored. The Admiralty will be paid for the additional expenses resulting from the scientific work. The *Acheron* was expected to leave Portsmouth on April 20, and to return to the United Kingdom in about six months.

The Future of the Norfolk Broads

IN replying to Mr. John Parker in an adjournment debate in the House of Commons on March 25, when the question of making the Norfolk Broads into a national park at an early date was raised, Mr. Hugh Molson, the joint parliamentary secretary to the Ministry of Transport and Civil Aviation, gave a useful statement of the present position. He stated that the matter had been considered by the National Parks Commission, set up in December 1949, which early reached two fundamental conclusions: first, that it would be unwise to designate the area without a clear prospect that the deterioration to which Mr. Parker referred could be halted; and secondly, that although the Act permits the Minister to pay a 100 per cent grant on waterways expenditure, it is reasonable that local interests, who will benefit from the work done, should contribute.

In April 1951 the National Parks Commission asked the then Minister for Housing and Local Government whether it could count on a contribution of, say, £30,000 a year from the Treasury towards the work that would be required. An extensive survey carried out by one of the Ministry's engineering inspectors in the following summer confirmed that the expenditure to make a thorough job would not be less than £750,000 and might well be £890,000 for a period of twenty years with considerable maintenance costs, and that not less than four million tons of silt would require to be deposited upon the adjoining agricultural land. After considering this report, the Ministry, in January 1953, informed the Commission that any scheme involving works on this scale must, for the time being, be regarded as out of the question. Mr. Molson added that the Nature Conservancy, and probably also the landowners, are opposed to the dumping of large quantities of silt upon the banks of the Broads, and the Ministry of Agriculture and Fisheries is concerned as to the effect of such dumping on fertility.

Mr. Molson said that he was not able to anticipate the Chancellor of the Exchequer's promised statement regarding the availability of the Land Fund for such purposes. There are, he thought, three possibilities. One is to designate the Broads as a national park and undertake the expenditure involved in the large-scale dredging. Secondly, the area could be designated in the hope that a certain amount of money might be available for some of the purposes required, and this the Commission would clearly consider. The third possibility is to leave matters as they are so far as the Government is concerned. Mr. Molson understood that local interests are doing some work at the present time and that some amenities which are of the greatest importance are being preserved. The matter is constantly under consideration by the National Parks Commission, which is in touch with the Ministry of Housing and Local Government on the subject, and technical difficulties make it uncertain at least whether the work could be satisfactorily carried out even if a large sum of money were available. In opening the debate, Mr. Parker cited the recent estimate that at least half an inch of deposit is added to the bottom of every Broad each year, that deterioration has proceeded much more rapidly in Broads closed to the public than in those still open, and that there is also some silting up of the through waterways. The 2,600 acres of open water in the Broads at the time of the Hobhouse Committee's Report is to be compared with three thousand acres fifty years ago and four thousand acres a hundred years ago.

First Forest Park in Northern Ireland

THE first forest park in Northern Ireland, Tollymore Park in County Down, will be open to the public from May 1. The Park, which covers an area of about twelve hundred acres, is beautifully situated at the foot of the Mourne Mountains, and the River Shimna runs through the forest, which was formerly owned by the Earl of Roden. The decision to create the Park has been taken under the Forestry Act (Northern Ireland) 1953, which empowers the Ministry of Agriculture to declare that any land owned by the Ministry shall be treated as a forest park, to which the public shall have access in accordance with by-laws. The Ministry proposes to open the Park to camping parties from youth organizations, and there will also be parking sites for about twenty caravans.

Russian Comfrey as a Crop

SINCE Russian comfrey (*Symphytum peregrinum*) was first introduced into Great Britain in 1870, its agricultural value has been a matter of some controversy. To secure more definite information regarding cultivation of this crop, and the methods for conserving and feeding it, a number of trials were carried out in 1954 in Great Britain and overseas under the ægis of the Henry Doubleday Research Association, Bocking, Braintree, Essex. The conclusions of these trials have been published by the Association under the title of "Russian Comfrey Report No. 1: The 1954 Research Results", by Lawrence D. Hills (pp. 36+5 plates; 1955; 3*s*.). The plant is a perennial, and, when established, will

produce a large bulk of foliage of high protein and low fibre content. The total yields from successive cuts recorded in the British trials average just over 25 tons per acre per annum, though much higher figures have been claimed on previous occasions. As with other crops, success depends on good management, and the report includes recommendations for its cultivation, stressing the need for keeping the land clean, well manured and the crop regularly cut. The most profitable stock to feed with comfrey are pigs and poultry, though horses also appear to thrive on it. Information regarding conservation is scanty; but methods of drying and making silage are under investigation. The perennial nature of the crop renders it difficult to fit in with ordinary rotations on a farm, and once established it is difficult to eradicate. Instructions are supplied in an appendix to deal with this latter contingency. The plant might, however, prove useful to the smallholder or poultry keeper.

Biology and Human Affairs

In November 1954 the joint committee of the various biological societies of Britain held a conference on endocrinology. In one of the papers, Dr. Thaddeus Mann examined the experimental approach to endocrinology, while in another Dr. H. Gardiner-Hill discussed endocrinology from the clinical point of view. These two papers have been reprinted in the current issue of *Biology and Human Affairs*, which also contains an article by Dr. H. A. Barnicot on biological variation in human populations (**20**, No. 2; February 1955). The journal also contains details of the British Social Biology Council's Summer School which, this year, will be held during August 15–29 at Driebergen in Holland. The School is to be divided into two study groups, one of which will examine the application of biological knowledge in agriculture and food production, and the other will investigate the social services in Holland, particularly in relation to health, child welfare and problem families. Further information about the School can be obtained from the British Social Biology Council, Tavistock House South, London, W.C.1.

National Museum of Canada: Annual Report for 1952–53

The annual report of the National Museum of Canada for 1952–53 (pp. 313+18 plates. Ottawa: Queen's Printer, 1954; 1.50 dollars) records a large number of field investigations and the collection of many specimens, the continuation of certain research projects and the initiation of new ones, the improvement and enlargement of certain exhibits, and the continuation of the educational programme. But in addition to these normal museum functions, and in common with many museums of the British Commonwealth, the report contains ten original illustrated papers by members of the staff. The subjects include anthropology and folk-lore (Marcel Rioux), a new species of Eurypterid from the Devonian of Gaspé (Louis S. Russell) and lichens of Cape Breton Islands (I. Mackenzie Lamb). All these subjects reflect the many interests of this national Museum.

Royal Society Depository of Unpublished Mathematical Tables

The following is a list of accessions to the Royal Society's depository of unpublished mathematical tables since the publication of the last list in *Nature* (**173**, 1221; 1954):

(42) Integrals of the types

$$M_{p,q}(a) = \int_0^a \frac{J_p(x)\, J_q(x)}{x^{p+q}}\, dx$$

and $$N_{p,q}(a) = \int_0^a \frac{I_p(x)\, I_q(x)}{x^{p+q}}\, dx$$

(Marconi's Wireless Telegraph Co., Ltd.);

(43) (i) Étude de $N = 5n^4 + 1$ et $N = 5n^2 + 1$
(ii) Étude de $N = 10n^2 - 1$ et $N = 10n^4 - 1$
(A. Ferrier);

(44) A generalized off-set circle probability distribution;

(45) Tables of $n = (m^3 + i)^{1/3}$;

(46) Tables of $|I| = \left| \int_0^\varphi \sec\theta \exp i\mu \sec\theta \, d\theta \right|$;

(47) Tables of functions associated with the Airy integral (M. Rothman);

(48) Table of two-fifths powers (Royal Aircraft Establishment);

(49) Étude de $N = 3n^2 - 1$ et $N = 3n^4 - 1$ (A. Ferrier);

(50) Étude de $N = 2^n \pm a$ (A. Ferrier);

(51) Numerical data relating to the flow of heat in tubes (A. K. Jenkins).

Tables 44–46 were compiled by the Admiralty Research Laboratory.

Further information about these tables can be obtained from the Assistant Secretary, Royal Society, Burlington House, London, W.1.

Royal Institution: Programme of Lectures

The programme of Friday Evening Discourses at the Royal Institution, Albemarle Street, London, W.1, for the after-Easter session covers as usual a wide range of subjects. The Discourses, which are now in their 130th year since Faraday first started them, begin on April 29 with a discourse by Mr. George Rylands on "Parts of Poetic Speech". The next two discourses will both be illustrated by experiments and demonstrations in the tradition of the Royal Institution. On May 6, Dr. F. P. Bowden, of the Department of Physical Chemistry, Cambridge, will talk on "Fast Reactions in Solids and the Birth and Growth of Explosions". On May 13, Prof. R. W. Douglas, of the Research Laboratories, General Electric Co., Ltd., recently appointed professor of glass technology in the University of Sheffield, will be speaking on "The No-man's Land between Conductors and Insulators". Sir Wilfrid Le Gros Clark is to speak on May 20 on "The Exposure of the Piltdown Forgery". After Whitsun, Sir Hugh Casson, director of architecture at the Festival of Britain, will be talking about his recent trip to Peking. This will be on June 3. The next discourse, on June 10, will be given by Sir Graham Sutton, director of the Meteorological Office, on "Weather Forecasting—the Future Outlook". The session will end on June 17, when Sir Harold Spencer Jones, Astronomer Royal, will speak on the plans for the International Geophysical Year, 1957–58. In addition to the discourses, Sir Lawrence Bragg will deliver one afternoon lecture on May 3 for fourth- and fifth-form pupils from London schools. This lecture will be on "Famous Scientists in the Royal Institution" and will be illustrated by experiments which were originally performed by Rumford, Young, Davy, Faraday, Tyndall and Dewar. The requests to attend this lecture have been so many that Sir Lawrence Bragg has agreed to repeat it on

May 4, 17 and 18. Thus some two thousand children will have had the opportunity of seeing these famous experiments performed in their original setting.

Summer School on Computers

A FOUR-WEEK course on digital and analogue computers and their application to electrical engineering problems will be given at the Imperial College of Science and Technology, London, during May 31–June 24. The course is intended to acquaint electrical engineers with the computing facilities that are becoming available, to introduce them to the methods used for the solution of typical engineering problems, and to instruct them in the presentation of problems for computation. It is being given by the Department of Electrical Engineering with the help of the Mathematics Department of the College, members of the staff at the National Physical Laboratory and various firms and organizations engaged in computer manufacture and application. Further information can be obtained from the Deputy Registrar, City and Guilds College, Exhibition Road, London, S.W.7. The number attending the course will be restricted to about twenty.

Royal Irish Academy

THE following have been elected members of the Royal Irish Academy: Prof. W. D. Gill, professor of geology and mineralogy, University of Dublin; Rev. F. J. B. Jennings, *O.F.M.*; H. E. Kilbride-Jones, archæologist; Prof. J. J. McHenry, professor of experimental physics, University College, Cork; E. M. Patterson, geologist, Imperial Chemical Industries, Ltd.; Dr. W. F. Pyle, reader in English and fellow of Trinity College, Dublin; Prof. D. E. W. Wormell, professor of Latin and fellow of Trinity College, Dublin.

University College of Rhodesia and Nyasaland

APPOINTMENTS to the following chairs have been made in the University College of Rhodesia and Nyasaland: *Agriculture*, Dr. A. G. Davis, reader in agronomy in Wye College, University of London; *Botany*, Prof. A. S. Boughey, formerly professor of botany in the University College of the Gold Coast; *Physics*, Dr. E. Leighton Yates, senior lecturer in physics in the University of Sheffield; and *Education*, Dr. H. J. Rousseau, formerly head of the Department of Education in the University College of Fort Hare, South Africa.

Chemical Society: Officers

OFFICERS of the Chemical Society have been elected as follows: *President*, Prof. W. Wardlaw; *Vice-Presidents*, Sir Ian Heilbron, Sir Cyril Hinshelwood, Prof. C. K. Ingold, Dr. W. H. Mills, Sir Eric Rideal, Sir Robert Robinson, Prof. R. D. Haworth, Prof. E. R. H. Jones, Prof. R. P. Linstead, Prof. H. W. Melville, Prof. M. Stacey and Sir Alexander Todd; *Honorary Treasurer*, Mr. M. W. Perrin; *Honorary Secretaries*, Prof. E. D. Hughes, Dr. L. E. Sutton and Prof. F. Bergel; *New Members of Council*, Dr. D. W. Adamson, Dr. G. R. Barker, Prof. F. Bell, Dr. A. Hickling, Dr. A. W. Johnson, Dr. A. Maccoll, Dr. F. H. Pollard, Dr. W. Wild and Dr. G. T. Young.

Social Research in Industry: Meeting in York

THE ACTON SOCIETY TRUST and the York Civic Trust are jointly holding a meeting in York during April 23–27 on social research in industry which will be similar to that held in York in October 1953. Half the participants at the meeting will be from abroad, nine countries in Europe being represented, and they will all be workers in sociology, psychology or anthropology actively engaged in studies of the behaviour of individuals or organizations in industry. The discussions will be both on actual pieces of research carried out and on problems of interest to research workers everywhere, such as achieving co-operation in industry and getting the results of research translated into action.

Announcements

H.R.H. THE DUKE OF GLOUCESTER will inaugurate the 15-MeV. linear accelerator at Saint Bartholomew's Hospital, London, E.C.1, on April 27. The equipment will be used for radiotherapy and radiobiological research.

WE regret to announce the death of Prof. Albert Einstein, For.Mem.R.S., of the Institute for Advanced Studies, Princeton, aged seventy-six.

THE British Coal Utilization Research Association at Leatherhead will hold open days on June 8–10, during which the work of the laboratories will be available for inspection by visitors; June 8 will be reserved for members of the Association and their friends.

THE seventh of the annual Symposia on Phytopharmacy and Phytiatry will be held in the Agronomic Institute, Ghent, during April 26–27, under the presidency of Prof. J. Van den Brande, rector of the Institute. Further information can be obtained from the Secretary of the Symposium at the Rijkslandbouwhogeschool, Coupure 233, Gent.

THE third assembly of the Israel Medical Association will be held in Israel during August 10–20, with sessions in Jerusalem, Haifa and Tel Aviv. An organized tour from Britain arranged in connexion with the meeting leaves London on August 8. Details, including the preliminary scientific programme, can be obtained from D. F. Long and Co., Travel House, Mornington Crescent, London, N.W.1.

THE Yorkshire Group of the Library Association has prepared a list of translators in Yorkshire (East and West Ridings), containing details of sixty-two translators arranged in alphabetical order, with language, place and subject indexes. The list is not comprehensive, as some translators were not prepared to take on additional work. Details of qualifications and experience, etc., have been supplied by the translators themselves. The list can be obtained from the Group Honorary Treasurer, at the Commercial Library, Bradford I, price 2*s.* 6*d.*

A CONFERENCE on Airglow and Auroræ is to be held at The Queen's University, Belfast, on September 6 and 7, that is, immediately after the Dublin assembly of the International Astronomical Union. Prof. S. Chapman will preside. Less time than is customary will be devoted to the reading of papers, the primary purpose of the Conference being to provide observers and theoretical workers who are actively engaged in the field with an opportunity of meeting and exchanging views on problems of common interest. Those wishing to have an invitation to attend should communicate with Prof. D. R. Bates or Dr. A. Dalgarno, Department of Applied Mathematics, The Queen's University, Belfast.

USE OF COLOURING MATTERS IN FOODS

THE addition of colour to food is common practice; but many colouring substances are toxic and some have already been prohibited. The main issue before the Food Standards Committee set up by the Ministry of Food* was whether the public health would best be safeguarded by extending the present list of prohibited colours or by introducing a list of permitted colours. At first it considered recommending the adoption of the list approved in the United States and Canada; but representation was made to it that "this list would be insufficient to meet the present needs of the food industry in this country". The United States list contains nineteen colours; the colours in use in Britain at the present time number seventy-nine.

The Committee came to the conclusion that "the present Regulations under which in practice almost all known synthetic colours can be used in foods are unsatisfactory", and it states that "a review of scientific literature reveals that for only comparatively few colours is there information as to chronic toxicity or carcinogenicity". It is disturbing to note that, out of the list of seventy-nine colours at present in actual use, the Committee found it necessary to recommend the rejection of thirty-five "because examination of the experimental evidence shows that they have definitely harmful effects on health, or that their chemical structure includes groupings likely to be set free in the body which have been shown to cause cancer or other harmful effects in animals or man". Only twelve out of the seventy-nine seemed definitely safe, the remaining thirty-two being colours "about which there was no direct evidence of toxicity or harmfulness" but about which there was equally room for doubt.

The Committee states that it has not been able to meet in full the stated requirements of the trade; but there is no doubt that it has gone as far as it could without subjecting the public to quite unnecessary risks, and it includes a recommendation that provision be made for additions to or deletions from the list as further information becomes available.

In view of the widespread use of colourings, it is perhaps not surprising that the Committee should so readily accept the need to continue to permit the use of at least some; but from a nutritional point of view there is much to be said against the practice, quite apart from any danger of toxicity. One can agree with the Committee that "it is generally accepted to be physiologically sound that food should be presented in as attractive a form as possible" and perhaps also that "without the addition of colour many foods would have a drab unattractive appearance". It should, however, be stressed that a drab unattractive appearance indicates a poor standard of catering and is commonly produced by methods of cooking which greatly lower the nutritive value of the food being cooked. If, for example, fish looks drab, let it be served with tomatoes or a naturally green vegetable; these will greatly add to the nutritive value of the meal, whereas dyeing the fish will not. Processing and cooking methods which give a high nutritive value to the food do not require the addition of dyestuffs to make the products attractive. It is necessary to emphasize, far more than the Committee has done, that colourings can be used "to mask the use of inferior ingredients and to give a false impression of quality".

M. W. Grant

* Ministry of Food. Food Standards Committee Report on Colouring Matters; Recommendations relating to the Use of Colouring Matters in Foods. Pp. 27. (London: H.M.S.O., 1954.) 1s. net.

SECOND INTERNATIONAL CONGRESS OF FILMOLOGY, PARIS

IT has been found necessary to coin a word to distinguish the study of the film in all its aspects from more limited forms of film study—such as study from the æsthetic angle or study directed towards film-making. Like 'musicology', the term 'filmology' seems to have become established. The Institut de Filmologie, under the double sponsorship of the Faculty of Letters and the Faculty of Science, was founded in the University of Paris in 1948. A course in filmology is provided, and a diploma granted for this subject.

The Second International Congress of Filmology was held in the University of Paris during February 19–23, under the presidency of M. Mario Roques. The executive delegate was M. G. Cohen-Séat (who is the director of the Institut de Filmologie), and the convener was Dr. W. D. Wall, of the Department of Education, Unesco; the presidents of the two Congress Sections were Prof. A. Michotte van den Berck, of the University of Louvain (unfortunately prevented from attending owing to ill-health), and Prof. H. Laugier, of the Sorbonne. Of the three hundred and thirty participants representing twenty-six countries, eight were from Great Britain, and two of these—Miss G. Keir and Prof. G. P. Meredith—presided over Congress sessions. The work of the Congress was at first carried out by seven groups, acting independently; then followed sessions of combinations of these groups, and, finally, all the group members came together to take part in symposia.

Group 1 of the Congress dealt with psycho-physiological effects of cinematograph projection. Problems of three-dimensional and of colour representation, and of sound-recording, were considered, as well as physiological effects and a number of isolated perceptual phenomena; attention was also paid to the electro-encephalograph in relation to the film. Among those contributing were J. Faure, Y. Gallifret, C. E. M. Hansel, G. Heuyer and S. Lebovici. Prof. M. J. Colle, who presided, pointed out that some of the effects of the stimulation of films can be studied by normal physiological procedure, for they are the result of innate reactions. But another and more important category of effects are those resulting from an interpretation of the stimuli, and are partly dependent on acquired experience. These latter effects can best be investigated by the methods of the psychologist.

The psychological approach was employed by Group 2 in its study of the reactions of cinema

audiences. Sociological problems of the cinema were examined by Group 3: the 'stereotypes' of the popular film, the intentional and unintentional propaganda of films, and the possibility of collecting material to provide a statistical basis for further sociological research. Group 4 dealt with the film as an instrument of teaching and research. Group 5 considered laws in relation to the cinema, the classifying of films according to their possible effects on viewers, and problems of censorship. Comparison of the film with other forms of expression was carried out by Group 6, and specifically with the medium of television by Group 7. The presidents of these six groups were M. Ponzo, M. J. Flaud, F. Buytendijk, G. Calo, B. Knipping and A. Marzi, and the chairmen at their various sessions were M. P. Fraisse, G. Friedmann, O. Klineberg, R. Lefranc, R. Bonnardel, R. Meili, E. Souriau, P. Francastel, H. Gratiot-Alphandery and H. Dieuzeide.

Not the least important filmological experiments reported during the Congress were those to do with modifications of the electro-encephalograph during cinematograph projection. These experiments have been carried out in France by J. Bert, G. Cohen-Séat, J. Faure, H. Gastaut, G. Heuyer, S. Lebovici, Mme. Rebeillard, Mlle. Daveau, and others, and some of the experiments have already been reported in an issue of the official journal of the Institut de Filmologie, *Revue internationale de Filmologie* (January–March, 1954). Sound films containing news-reel type items have been used, and into these films have been infrequently inserted strips of film which leave the screen suddenly lighted but blank for a short period. In one experiment a 'western' adventure film and a film of strong emotional content—showing delinquents—have been used. The subjects of the experiments have been various, and in one experiment have included animal subjects (dogs). The effect on the electro-encephalograph of the fluctuation of light intensity during projection, isolated from the effect of representation, has been examined; and breathing and other physiological effects have been recorded.

Present knowledge is insufficient to permit defined interpretations of the electro-encephalograph. There were factors apart from those to do with the film projection which may have caused some of the observed modulations, and the experimenters themselves do not claim to have arrived at sure conclusions. Nevertheless, these experiments represent pioneering work of a kind that may eventually lead to important advances in knowledge not only of the effects of film projection, but also in electro-encephalograph techniques and in the study of the brain. The film provides the research worker in this field with a convenient instrument. It may be that at length the film will provide the research worker in his laboratory with the means of presenting actual-life situations to the subjects of his experiments, and of studying the effects produced by such situations. First, however, it has to be established that reactions and thought processes similar to those that occur in ordinary life (when not watching films) can be brought about by film representation, and by what kind of film method. In relation to this, C. Denis Pegge maintained that there are two fundamentally different modes of mental reception from films, depending particularly on the use or non-use of speech; and he suggested that electro-encephalographic experiments might profitably be carried out to test this hypothesis.

A criticism made at the Congress of the electro-encephalographic experiments so far accomplished was that some of the observed effects might have resulted from forms of representation other than that of the film; also, the primary need of establishing a classification of spectator reactions was discussed.

The object of this Congress, as of all international congresses—to make known what is being done in different countries—was admirably fulfilled, and not the least of its benefits were the personal contacts it allowed. Much of the material of its communications must probably remain unco-ordinated; but some clarification as to the best way of sub-dividing the large subject of filmology may well follow the arranging of the material for publication. This considerable task is now being tackled by the Congress Committee, and should result in an important book. Thanks are due to those who organized the Congress, including the general and administrative secretaries, Mme. Bianka Zazzo and Mme. Chantal Loiseau; these latter were responsible for detailed arrangements which contributed to making this Congress not only valuable, but also most enjoyable. C. Denis Pegge

COMMONWEALTH FUND, NEW YORK

REPORT FOR THE YEAR 1953–54

THE thirty-sixth annual report of the Commonwealth Fund, which covers the year ended June 30, 1954*, lists more than forty appropriations made during 1953–54. Of the nineteen appropriations for medical education, thirteen were new grants. These grants fall into six general groups: those aimed at encouraging the better integration of professional and school or college education; those to assist the integrated teaching of the basic sciences to medical students in their first and second years; those to develop broader and more satisfactory relationships with patients by encouraging integrated teaching in the clinical years of the medical curriculum and better relations between the outpatient department, home care and the community; those in mental health, where the integration of psychiatry and clinical medicine is being encouraged, and the Fund is this year assisting a programme in preventive psychiatry, both teaching and research; those in nursing activities, chiefly to clarify the place of nursing in health activities and the training required for it; and those concerned with educational research and evaluation. The last, it is hoped, will lead to the development of improved techniques for assessing particular accomplishments or changes in students, better methods of selecting students for admission to medical schools, and the better definition and clarification of the objectives of the medical faculties themselves, as well as the provision of factual information as a basis both of administrative decisions and of the judgments that students are called upon to make about their future careers.

Five grants were made for experimental health services, the largest being a three-year grant to the Mary Imogene Bassett Hospital, Cooperstown, New York, towards the provision of a psychiatric service for a scattered rural constituency. Another was

* Commonwealth Fund. Thirty-sixth Annual Report for the Year ending June 30, 1954. Pp. ix+42. (Commonwealth Fund, 1 East 75th Street, New York, 1954.)

towards the cost of a survey of the incidence and nature of long-term illnesses in a cross-section of the population of Baltimore, Maryland, and a third for a survey of the Rochester regional hospital programme. The other two were for a study of family experience with medical care in an urban population group and for planning and organizing programmes to improve medical care in selected Tennessee communities.

Of the thirteen grants for medical research, four were new, one of these being a survey of the work of the Child Research Council of the School of Medicine, University of Colorado. Much the largest grants in this group are those for studies of neural correlates of mental activity at the University of California School of Medicine and for the study of personality development at the Child Study Centre, Yale University; but large grants were also made for studies of resistance and susceptibility to experimental tuberculosis (Henry Phipps Institute, University of Pennsylvania School of Medicine), histochemical studies of the sub-microscopic organization of cells and extracellular substances (Department of Anatomy, University of Chicago), studies of cerebral function (New York University College of Medicine), a twin study of the hereditary and environmental factors in body build (Institute for the Study of Human Variation, Columbia University) and a study of the biological role of steroids (Worcester Foundation for Experimental Biology).

For advanced fellowships in medicine and allied fields, the Fund appropriated 100 million dollars, and the eighteen awards included eight for interdisciplinary study, five for special work relating to psychiatry, two for training in research and three for special experience and study. In the field of international education the major appropriation in 1953–54 was 685,890,000 dollars for a two-year budget for the established programme of the Commonwealth Fund fellowships for advanced study and travel in the United States. New awards under the programme, which also provides for the maintenance of Harkness House, London, included twenty general British fellowships, three Home, six Dominion and two Colonial Civil Service fellowships, and three journalism fellowships, while a two-year grant was made to the Institute of International Education and a one-year grant to the Salzburg Seminar in American Studies.

BLOOD COAGULATION AND THROMBOSIS

TWO main difficulties are immediately recognizable in research on blood coagulation. Only two or three of the dozen or so components of the blood-clotting system have been obtained in a state approaching purity, but the continued application of physico-chemical separations will probably improve this situation in the course of time. The second difficulty is the multiplicity of terms for components which can only be recognized by their effect on a clotting system, and thus it is very welcome news that an International Committee on the Nomenclature of Blood Clotting Factors is being formed to resolve the existing confusion. The editor and panel of contributors to the recent issue of the *British Medical Bulletin* (11, No. 1; 1955) are therefore to be congratulated on maintaining the high standard of review associated with the journal in a field where there are exceptional difficulties.

In his introduction, R. G. Macfarlane points out that research in blood coagulation, which for more than a century has moved at a strictly academic tempo, has recently acquired a remarkable acceleration which he attributes partly to studies of hæmorrhagic states (defective coagulation) and partly to the introduction of anticoagulant therapy for thrombosis (excessive coagulation). Tests of clotting efficiency, discussed by Dr. Rosemary Biggs, contribute both to the diagnosis of hæmorrhagic states and to the control of anticoagulant therapy.

Recent advances in the understanding of hæmophilia and allied disorders are presented by W. R. Pitney and J. V. Dacie. C. Hougie discusses another group of coagulation defects—those due to the development of anticoagulant factors in the blood. J. F. Ackroyd contributes two articles on the role of platelets in normal and pathological conditions, and J. B. Duguid discusses mural thrombosis in arteries.

Dr. Catherine Burt gives a very practical review of the clinical uses of anticoagulant drugs, discussing the heparin type of anticoagulant which acts directly on the blood-clotting system and also the coumarin type which acts by reducing the formation of blood-clotting factors. A table clearly sets out the doses, the times to obtain an effect and to return to normal afterwards, for the various coumarin-type drugs; the effect of the heparin type is obtained immediately after injection. Contra-indications and the results of therapy in various diseases are very thoroughly reviewed.

K. Bailey and F. R. Bettelheim discuss the conversion of soluble fibrinogen to insoluble fibrin by the enzyme thrombin. Here the picture of coagulation is clearer since fibrinogen and thrombin have recently been prepared in what appear to be pure forms. The discovery that the N-terminal group of fibrin differed from that of fibrinogen led to the isolation of a peptide split off from fibrinogen by the action of thrombin during clot formation. These facts, first discovered with bovine fibrinogen, are being confirmed for human fibrinogen by current research. R. A. Kekwick describes the large-scale separation of some of the clotting factors from human plasma. These factors are generally required in a very pure state for diagnosis and research; but for clinical application moderate purity suffices.

A careful analysis of the mode of action of coumarin drugs is presented by A. S. Douglas, who concludes that the serum of patients under therapy with these drugs is defective in its ability to form thromboplastin. R. B. Hunter and D. M. Shepherd contribute an interesting article on the chemistry of coumarin anticoagulant drugs in which they point out that it is still not possible to define the minimum structural characteristics that are required to confer anticoagulant powers on the molecule. The relationship between anticoagulant activity and the opposing vitamin K activity is discussed, and it is pointed out that competitive inhibition between coumarin anticoagulants and vitamin K exists only over a very limited dose-range. Vitamin K is a growth factor for certain micro-organisms, and a compound with anti-vitamin K activity in this respect may or may not be an anticoagulant.

A very comprehensive review of the chemistry and mode of action of heparin and related compounds is provided by K. W. Walton. After tracing the history of the purification of heparin through to present-day

views on its structure, the relation between structure and activity is discussed. The most recently discovered feature of heparin structure, the sulphated amino-group, may or may not turn out to be the key to the remarkably high anticoagulant activity of heparin as compared with other sulphated polysaccharides. Regarding the mode of action of heparin on the clotting system, it seems probable that heparin intervenes at more than one point. It certainly functions as an antithrombin and probably acts also against thromboplastin.

In a fine concluding article entitled "The Rubicon: Changing Views on the Relationship of Thrombosis and Blood Coagulation", Prof. A. H. T. Robb-Smith entertains us with a glimpse of a review of coagulation and thrombosis as it would have been written a century ago, perhaps in the "British Medical Almanack" of 1855. He manages to include much that is illuminating to-day and inspiring for the future, and some very sobering thoughts on the necessity of studying coagulation *in vivo* and not only in artificial systems. It appears that, if we could predict the onset of thrombosis, we could, by careful use of the drugs available to-day, avoid the disease altogether—a worthy objective for the scientific approach in medicine.

C. R. Ricketts

UNIVERSITY OF LEEDS

At a meeting of the Court of the University of Leeds on December 15, 1954, the vice-chancellor, Sir Charles Morris, said that if the universities of Great Britain have succeeded in assimilating new studies which are most exigent of both human and material resources without destroying the essential nature of academic communities, this is largely due to the sympathy and wisdom of successive governments, which have seen it as their first task to enable each university to preserve its own special academic character and balance of interests. Only when this is secured has the government sought to encourage developments in particular fields, such as studies in oriental languages, social studies and higher technological education. In regard to the last-named, the Government's most urgent concern is to increase the number of graduates in technology available for industry and commerce after taking their first degree. So far as the University of Leeds is concerned, continued Sir Charles, the main limiting factor is accommodation; but some overcrowding has been accepted in the expectation that the necessary new buildings and extensions can be undertaken without great delay.

Sir Charles stated that it was expected to complete the chemistry and physics buildings of the University within the next few weeks, and a capital grant from the University Grants Committee will enable the work to begin without delay upon the first stage of the remaining extension; this extension is an essential part of the expansion of the technological departments, for which a new building has in addition been planned. Work on the first section of this latter building, to house the Department of Fuel Science, including now chemical engineering and metallurgy, was expected to start in about three months, with the aid of a large capital grant from the University Grants Committee. Accommodation available for the Medical School is also being increased, including new accommodation for the Departments of Biochemistry and of General Medicine; and in due course, as part of the City development plan for the area north of the General Infirmary, it is hoped to plan and build a new Medical School. It is hoped to start the building of the first section of the new arts block early in 1957. This building, on the south side of University Road, is to have an impressive frontage looking south and is to balance the science block on the north side of the Parkinson Building.

Referring to the Government's known view that leaders of the future in technology should be educated in the university manner, side by side with the scientific workers and medical workers and those destined for the older professions, Sir Charles said that it is of the greatest importance that the universities should retain their traditional character and way of life. He thought that at Leeds, while not doing all that could be done, they were succeeding in this and were determined to do better still.

ANATOMY AND ANGIOSPERM CLASSIFICATION

In an essay entitled "An Anatomist's Views on Angiosperm Classification" (*Kew Bull.*, No. 3, 427; 1954), C. R. Metcalfe has applied himself to the problem of how the taxonomist, confronted with the Angiosperms in all their abundance and diversity of species, can be helped in his aim to produce a natural classification, by making use of the results of laboratory investigations. Long experience has shown that the morphology of the reproductive structures, apparently less plastic than the other parts of the plant body, affords the most reliable criteria for purposes of classification. Nevertheless, the case is now forcefully presented that the micro-morphological characters of the vegetative organs can be used to advantage in taxonomic studies. Indeed, it has been shown that the conclusions based on the observation of such characters may show a large measure of agreement with those reached by the traditional methods.

In the body of the article, the author discusses critically, with citation of many interesting examples, the parallelisms in the evolution of the woody elements, for example, tracheids to vessels, scalariform end-wall plates to simple perforations, etc., the relationship of herbs to ligneous plants, and the *Durian* theory. He notes that if the diagnostic microscopic characters for most taxonomic groups above the level of families are surveyed, it becomes evident that orders and taxa of higher rank are heterogeneous. From this he concludes that orders are probably, with some exceptions, taxonomic conveniences, rather than assemblages of genetically related plants. By contrast, a study of the diagnostic microscopic characters of genera in individual families supports the view that most families appear to be homogeneous and therefore constitute natural groups. Where exceptions occur, this generally indicates a need for some taxonomic revision, or that a large family needs to be divided into distinct groups. The author concludes that taxonomy is likely to develop to the best advantage by the collaboration of the herbarium botanist with those who approach the subject by laboratory techniques. Moreover, the laboratory approach to taxonomy should lead to a closer integration of systematic with other branches of botany.

MARINE BIOLOGICAL RESEARCH

THE Marine Biological Association reports (*J. Mar. Biol. Assoc.*, 33, 3; 1954) the completion of the research vessel, *Sarsia*, and gives a photograph of this fine ship. Registered as ninety-five tons, she has two laboratories, a crew of sixteen, and accommodation for four scientists. An impressive account of work in progress is given in the report of the Council, and it is a pleasure to record an increase in membership of the Association of sixty-one, making a total of 770, and a satisfactory balance sheet.

In the present number, completing the thirty-third volume, there are sixteen papers, of which the most important are described below.

Dr. Vera Fretter and Prof. A. Graham, continuing their studies of small or aberrant gastropods, contribute an interesting account of the sand-burrowing *Acteon tornatilis*, a primitive British opisthobranch. This paper is illustrated by handsome drawings. In structure, *Acteon* forms a link between prosobranchs and opisthobranchs, and also exhibits more advanced and specialized characters.

Dr. Daphne Atkins has investigated the swimming habits of brachyuran megalopæ. Of the twenty-five species of crabs occurring at Plymouth, twenty-two swim in stream-lined fashion by tucking the chelipeds and first two pairs of pereiopods beneath the body, the last two pairs being wrapped over the back, with the third pair looped around the eye-stalks. Three species fold all the legs beneath the body; these probably have a very short pelagic existence.

Dr. R. H. Millar contributes two papers on tunicates, one a description of a new genus and species, *Protostyela heterobranchia*, from west Scottish coasts. This is based on a single zooid, which is remarkable in possessing transverse stigmata. The second paper is an account of breeding and development in *Pelonaia corrugata*, an oviparous species, without pelagic larval stage.

Another interesting study from the Clyde area is a paper by Dr. R. B. Pike on the biology of *Spirontocaris lilljeborgii*. Using methods similar to those in his work on *Pandalus*, Dr. Pike proves that this species of *Spirontocaris* is dicœcious, the males living one or two years, the females two or three years, and breeding for the first time in the second year. Egg-laying occurs in November and hatching in March. Sexual characters appear in the larvæ within six months of hatching.

Dr. Alexandrowicz adds to his histological series an account of the innervation of the heart of *Marinogammarus marinus*. He found a local system, situated dorsally, paired connexions with the central nervous system, and nerves supplying the valves. There is an ancillary system to the alary muscles and wall of the pericardium.

Dr. R. Phillips Dales and Dr. G. Y. Kennedy have investigated the orange, brown and green pigments of *Nereis diversicolor*, and the relation between their predominance and sexual reproduction. The green colour, due to biliverdin, is formed by the breakdown of the hæmoglobin of the blood. Dr. Kennedy and Dr. H. G. Vevers studied porphyrins in British marine invertebrates. Of forty-eight species, only seven, belonging to the phyla Annelida, Mollusca and Echinodermata, possessed any form of porphyrin, and none was found in cœlenterates, Crustacea or tunicates.

Dr. L. R. Fisher, Dr. S. K. Kon and Dr. S. Y. Thompson have published their second paper on vitamin A and carotenoids in Crustacea, with special reference to seasonal variation. Present mainly in the eye in euphausiids, astaxanthin and vitamin A accumulate during the spring and autumn feeding periods, in association with diatom increases at those times. In brown shrimps and Norway lobsters there was no seasonal variation; but in the common lobster the highest concentration is in the spring. It is suggested that astaxanthin is a possible precursor of vitamin A. If this is so, euphausiids are unique among Crustacea in being able to produce vitamin A from the "ubiquitous crustacean pigment astaxanthin".

Dr. A. J. Matty discusses thyroid function in the dogfish, and the effects of injecting extracts of the gland into rats. His results are not conclusive; we wish him success in his visit to Barbados as Nuffield Fellow, in search of material from local fishes.

On the botanical side, Dr. Daphne Atkins contributes two papers on marine fungi belonging to the family Saprolegniaceae, affecting marine Crustacea and other invertebrates. The first species, *Leptolegnia marina*, attacks the body, eggs and embryos of *Pinnotheres pisum* and *P. veterum*, as well as two lamellibranchs, *Barnea candida* and *Cardium echinatum*. The second species, *Plectospira dubia*, attacks several kinds of Crustacea and is less pathogenic.

Two papers deal with oceanographical problems. Dr. J. N. Carruthers describes a penetrometer for use on submerged beaches, based on that used by road surveyors, and Mr. W. S. Preddy discusses the mixing of waters in the Thames estuary, with special reference to pollution.

EXPERIMENTAL EVIDENCE FOR THE COLLECTIVE NATURE OF THE CHARACTERISTIC ELECTRON-ENERGY LOSSES IN SOLIDS

By Dr. D. GABOR and G. W. JULL

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IN a study extending over the past three years, we have been investigating the characteristic 'line' spectra of the energy losses of electrons in thin metal foils, first discovered by Ruthemann[1] and since confirmed by other workers[2]. The apparatus used was a new electrostatic spectrograph, proposed by one of us[3], in which the electrons describe helical trajectories. In the course of this work we were struck with the erratic behaviour of the spectra, not reported by previous workers but evident enough from the wide discrepancies between their results. As in the case of most metals the variability might have been ascribed to chemical changes in the thin foils, we turned to gold, which at least gave clear evidence of a dependence of these spectra on structure, as distinct from chemical composition.

In one series of experiments we deposited gold films in two different ways on thin carbon films, prepared by the method of Bradley[4]. These proved the best substrates, owing to their low absorption and to the continuous character of their loss spectrum, shown in Fig. 1, curve *C*. Moreover, this spectrum is almost identical with that of the carbonaceous 'contamination' which covers every object in demountable vacuum devices under electron bombardment. One method (*A*) of depositing the gold film was by an uninterrupted process of evaporation. Fig. 1 shows the spectra of two continuous films, *A*1 and *A*2, of 110 and 210 A. thickness, respectively, produced by this method. The thickness was measured by simultaneously depositing a control film on a glass plate, at half the distance from the evaporator, measuring it optically by Tolansky's method, and dividing it by 4. The electron micrograph in Fig. 2 confirms the continuous character of layers produced by this method. In method *B*, the deposition was carried out in steps of about 30 A. each. The evaporator operated in the same vacuum as the spectrograph, and the specimen could be transferred instantly into the spectrograph, without breaking the vacuum. Every time a layer of about 30 A. was deposited, it was measured, which meant exposing it for about 20 min. to the electron beam. This was sufficient to deposit on it at least 10 A. of contamination; thus the specimen consisted ultimately of alternate layers of gold and of carbonaceous matter. Fig. 3 is an electron micrograph of such a stratified specimen of 170 A. aggregate gold thickness. It appears strongly granulated, presumably through the lateral rearrangement of the gold atoms under the heating by the electron beam. The granules, with the exception of the smallest ones, are certainly not globular in shape, but may be visualized as flat flakes, with a layer structure.

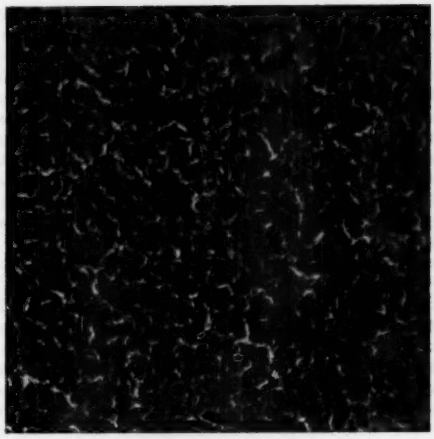

Fig. 2. Electron micrograph of gold foil of the 'continuous type', produced by uninterrupted deposition

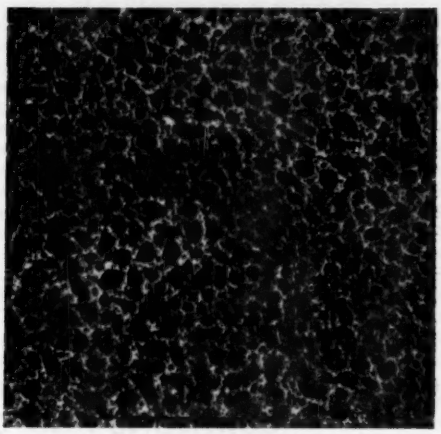

Fig. 3. Electron micrograph of the stratified type, 170 A. aggregate gold thickness, built up of six layers of gold, alternating with carbonaceous layers of 'contamination'

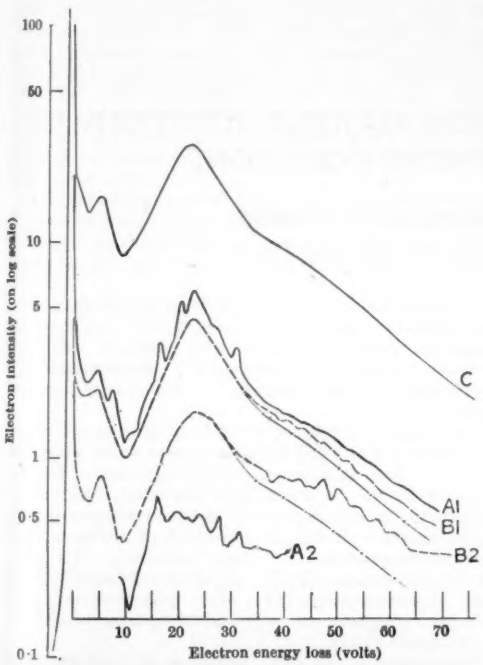

Fig. 1. Energy loss spectra of 10·5 keV. electrons in gold foils. *C*, carbon substrate, about 100 A. thick. *A*1, Continuous gold foil, 110 A. *A*2, Continuous gold film, 210 A. *B*1, Stratified film, 120 A. aggregate gold thickness. *B*2, stratified, 170 A.

The curves *A*1, *A*2 and *B*1, *B*2 reveal clearly the presence of a strong group of characteristic losses between 8 and 32 eV. in the continuous gold foils, and their total absence in the stratified films. On the other hand, another group of losses between 40 and 65 eV. comes out with about equal intensity in the *A*- and *B*-foils. (Curve *A*2 is not continued into this range; but the presence of this group in continuous films was confirmed in other experiments.) Thus the second group may be due to the interaction of the beam electrons with single core-electrons, but not the first. One must expect interaction with single electrons, especially with those in the inner shells, to be independent of the structure and to depend only on the aggregate gold thickness. The curves *B*1 and *B*2 indicate a process which does not start below a certain critical thickness, and this cannot be explained by single collisions.

The question arises whether the theory of collective interaction, first proposed by Bohm and Pines[5], might be able to account for this phenomenon. The answer is yes, with certain qualifications.

'Collective' losses are due to the transfer of one quantum to the vibrational modes of the electron gas in the metal. One of us (D. G., unpublished work) has investigated a model in which the metal is replaced by a sheet of an electron gas, with vibrational modes distributed according to the dispersion law of Bohm and Gross, each with the zero-point energy $\frac{1}{2}i\hbar\omega$, with random phases. The incident electron wave interacts with these oscillators during a time τ. This must not be identified with the transit time of the electrons through the metal layer; for with 10-keV. electrons and characteristic losses of the order of 15 eV., the transit angle $\omega\tau$ would be only about 2π for the thickest foils investigated, and one could not explain the sharp lines of a width of at most 1–2 eV. which have been observed, even in much thinner foils. The interaction time must be interpreted as the time in which the wave train, defined by the uncertainty of thermal emission velocities, passes through the foil. This gives resonances of the required sharpness, since this time corresponds to a foil thickness of about 1500 A. for 10-keV. electrons emitted by a tungsten cathode, and to transit angles of the order $10 \times 2\pi$.

As the interaction time is practically independent of the thickness of the foil, an effect such as we have observed can be explained in two ways only. One is, that foils of type *B* were in fact so finely granulated transversally to the thickness that the beam was strongly diffracted, and only a fraction of it passed the fine aperture of the spectrometer. This, however, is directly contradicted by electron diffraction diagrams, which show unmistakably that foils of type *A* are in fact more finely granulated transversally than foils of type *B*, which seem to have undergone a crystallization process in two dimensions.

The other explanation, and the only one which we now believe fits the facts, is that the sheets of type *B* have less vibrational modes per unit volume than continuous foils of type *A*. This is readily understood on the basis of the theory of collective oscillations of plasmas, since the longest wave which can exist in a sheet of thickness *a* has the wave-length $2a$. But theory shows that this 'long-wave cut-off' can become effective with *a* of the order of 30 A. only if we assume that the 'short-wave cut-off' due to damping is at much longer wave-lengths than hitherto assumed; not at 1–2 A., as in the theory of Pines and Bohm, but perhaps at 50–60 A. Moreover, the multiplicity of the characteristic loss spectrum forces us to believe that the spectrum mode of the electron gas in most metals forms not one wide band, but a series of narrow bands, each of a fraction of a volt only.

This investigation was carried out in the Electronics Laboratory of the Department of Electrical Engineering, Imperial College of Science and Technology. One of us (G. W. J.) thanks the Athlone Fellowship Committee, the Canadian Research Council and the Canadian Defence Research Board for enabling him to carry out this work. We thank Messrs. M. E. Haine and A. W. Agar, of the Research Laboratory, Associated Electrical Industries, Ltd., Aldermaston, for taking electron micrographs and diffraction diagrams of our specimens. [Feb. 7

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CHEMICAL EFFECTS OF X-RAYS UPON AQUEOUS SOLUTIONS OF CORTISONE AND DEOXYCORTICOSTERONE

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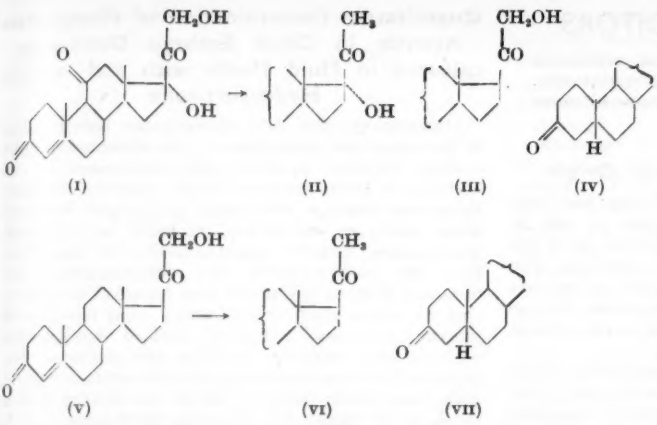
THE effects of X-rays (200 kV.) upon some steroids in solution have been reported earlier by Keller and Weiss[1], who found that the chemical effects were mainly oxidative in nature: for example, hydroxylation of double bonds or other activated positions, oxidation of secondary alcohols to ketones. Coleby, Keller and Weiss[2] observed similar effects when steroids dissolved in certain organic solvents were irradiated. Barron[3] measured the decrease in ultra-violet absorption on irradiating aqueous solutions of cortisone acetate and hydroxycorticosterone in the presence and absence of oxygen. We now wish to report the identification of some products formed from cortisone and deoxycorticosterone when their aqueous solutions are irradiated with X-rays (200 kV.)[4].

Identification is based upon comparison with authentic materials in as many of the following tests as could be applied: chromatographic properties of the products and of their acetates[5]; ultra-violet absorption spectra; reaction with tetrazolium salts; the Porter–Silber reaction for 17α : 21-dihydroxy-20-oxo-steroids; absorption spectra in concentrated sulphuric acid; oxidation with chromic oxide or sodium bismuthate, followed by chromatographic resolution of the products; infra-red absorption spectra.

By these methods we have been able to show the occurrence of the following processes when *deaerated* solutions are irradiated: dehydroxylation in the 17α- or in the 21-position of cortisone, and correspondingly in the 21-position of deoxycorticosterone; hydrogenation of the double bond of cortisone and deoxycorticosterone. Thus, cortisone (I) gave 21-deoxycortisone (II), 11-dehydrocorticosterone (III) and dihydrocortisone (IV), while deoxycorticosterone (V) gave progesterone (VI) and 21-hydroxypregnane-3 : 20-dione (VII).

Furthermore, we have evidence to indicate that the following processes also occur with cortisone solutions: (i) complete reduction of the Δ^4-3-oxo system to give 3β-hydroxy derivatives, (ii) reduction



of the 3-oxo group (before reduction of the Δ^4-double bond occurs), (iii) addition of one hydroxyl group and one hydrogen atom to the double bond, (iv) elimination of a carbon atom from ring *A* to give *A-nor*-3-oxo-steroids (this last reaction appears to be the most important single reaction occurring during radiolysis). A small amount of adrenosterone, formed by elimination of the side-chain of cortisone, was also isolated.

The overall reaction of corticosteroids during radiolysis may be studied by the decrease in absorption due to the Δ^4-3-oxo group and by the decrease in ability to react with tetrazolium salts. The attack upon the side-chain is comparatively slight, and it can be accounted for quantitatively in terms of the products mentioned above. The attack upon the Δ^4-3-oxo system is much more marked, and its extent decreases rapidly with increasing dose (see Fig. 1 for cortisone solutions; similar results were obtained with deoxycorticosterone solutions). This indicates that cortisone is strongly 'protected' by its reaction products, that is, these react with the radicals produced by ionizing radiations more readily than does cortisone.

It is generally agreed that the absorption of hard X-rays by water gives rise to hydrogen atoms and hydroxyl radicals ($H_2O \longrightarrow H + OH$) and, to a much smaller extent, molecular hydrogen and hydrogen peroxide[6]. Hydrogen and hydrogen peroxide in the concentrations formed during radiolysis were found to be without action upon corticosteroids, so that the observed reactions may be ascribed to hydrogen atoms and hydroxyl radicals. The products identified above are, presumably, the result of reaction with hydrogen atoms.

When molecular oxygen is present in solution, the hydrogen atoms are readily removed by the reaction: $H + O_2 \rightarrow HO_2$. The irradiation of cortisone solutions saturated with oxygen was found to give products differing markedly from those obtained in the absence of oxygen. Again, a small amount of adrenosterone was obtained, and some of the suspected 17α : 21-dihydroxy-*A-nor*pregnane-3 : 11-20-trione; but the remainder of the products isolated could not be identified with those obtained from deaerated solutions. The curve obtained for the destruction of the Δ^4-3-oxo system on irradiation of oxygenated solutions (see Fig. 1) varies linearly with increasing dose, showing that cortisone is not 'protected' by its reaction products in the presence of oxygen; this is true even when a large proportion of the cortisone initially present has been destroyed. In general, it would be expected that attack of the steroid molecule by a free radical would produce another radical which would readily add on molecular oxygen, leading eventually to a hydroperoxide type of molecule[7]. It was found that irradiated oxygenated solutions did give reactions indicating the presence of substantial quantities of hydroperoxides, but these substances did not survive the process of chromatography; presumably the numerous substances detected chromatographically represent the decomposition products of these hydroperoxides.

The isolation of the compounds reported above is interesting because of the complete contrast with the mainly oxidative reactions previously observed on irradiation of steroid solutions[1,2].

While it has long been recognized that irradiation of aqueous solutions can cause reductions, the dehydroxylation and hydrogenation of double bonds of organic compounds have not previously been reported. Some of these reactions are also of interest in that similar products have been isolated in the metabolism of corticosteroids[8].

Work is in progress to complete the isolation and identification of other products formed in the radiolysis. We gratefully acknowledge the financial assistance of the Medical Research Council and of the Northern Council of the British Empire Cancer Campaign in support of this work. Infra-red spectra were measured with the kind co-operation of Dr. A. E. Kellie, of the Courtauld Institute of Biochemistry. [Feb. 1

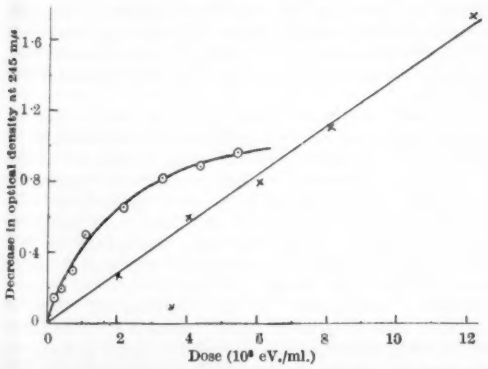


Fig. 1. Decrease in absorption at 245 mμ (0·5 cm. cells) against radiation energy absorbed (in 10^{18} eV. per ml.) for aqueous cortisone solutions. —⊙—⊙—, deaerated solutions; —×—×—, oxygenated solutions

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LETTERS TO THE EDITORS

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A New Antibiotic of Bacterial Origin

An antibiotic with therapeutic activity has been obtained from a spore-bearing bacillus of the *B. pumilis* group. The organism was isolated from soil collected in East Africa by Dr. Philip Spensley. The antibiotic is obtained in good yield from a medium containing inorganic salts, ammonium citrate, glucose and meat extract, both in shallow-layer and in aerated deep cultures.

The culture is acidified to *p*H 2·5, and ammonium sulphate added to 20 per cent concentration. The precipitate is collected by centrifugation, extracted with ethanol and the extract evaporated to dryness. The solid residue is washed with ether and with water, and the insoluble portion dissolved in ethanol and passed through a column of alumina. The active substance is obtained by evaporating the eluate to dryness and is crystallized from a mixture of acetic acid and ethyl acetate.

The antibiotic is a white crystalline solid sparingly soluble in water and turning yellow on exposure to light. It discolours at 232°, sinters at 238° and appears to melt at 252°. It has the composition C = 48·9, H = 4·7, N = 13·7, S = 16·0, O = 16·7 per cent, corresponding to a minimal formula of $C_9H_9N_3O_2S$. It does not give a ninhydrin test even after hydrolysis with hydrochloric acid, and so is unusual in being a non-peptide antibiotic from a bacterial source.

In nutrient broth it inhibits the growth of *Staphylococcus aureus* at a dilution of 1 in 20 million, of *Pasteurella muriseptica* at 1 in 50 million, of *Streptococcus haemolyticus* group *A* at 1 in 18 million and of an avirulent *Mycobacterium tuberculosis* at 1 in 200,000. It is not active against *Bact. coli*, *Shigella flexnerii* or *Candida albicans* at 1 in 25,000. It is just as active in whole blood as in broth against *S. haemolyticus*.

The substance is non-toxic. Mice survived the highest doses given, namely, 1 gm. per kgm. subcutaneously and 0·5 gm. per kgm. subcutaneously repeated daily. It is effective against hæmolytic streptococcal infection in mice. A single 2·5 mgm. intraperitoneal dose given up to five hours after the infection gave 100 per cent protection against an intraperitoneal infection of 1,000 lethal doses. Repeated 5 mgm. intraperitoneal doses of antibiotic saved all mice receiving a subcutaneous infection of 10 lethal doses. Daily 5 mgm. subcutaneous doses saved only 50 per cent of mice receiving 1,000 lethal doses of streptococci intraperitoneally. It was inactive by the oral route. The reduced effectiveness by the subcutaneous route is probably due to very slow absorption caused by its low solubility.

Larger quantities of antibiotic are being prepared and a further investigation of its chemical nature and therapeutic properties will be made. I wish to thank Mr. J. E. Lee for technical assistance.

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Quantitative Determination of Phosphatase Activity in Chick Embryo Duodenum cultured in Fluid Media with and without Hydrocortisone

Differentiation and phosphatase accumulation in the intestinal epithelium of the sixteen-day chick embryo cultured *in vitro* were accelerated by the addition of hydrocortisone to the nutritive medium[1]. When an attempt was made to culture relatively large pieces of duodenum, in order to determine phosphatase content quantitatively, it was found that the best survival and differentiation were obtained in those specimens that liquefied the plasma clot on which they were placed; such free-floating pieces maintained a normal surface configuration without any tendency to form the elaborate outgrowths that develop when a solid substrate is present. This observation has now led to the finding that as much as 25 mgm. of embryonic duodenum may be successfully cultured in 2 ml. of fluid, in a 25-ml. Erlenmeyer flask.

In the principal experiments described in this communication, the duodenal loops of sixteen-day chick embryos were excised under sterile conditions, placed in Earle's saline solution, and split lengthwise, each half being used for a single culture. Each half was cut into eight to fifteen fragments weighing 1–2 mgm. apiece, and these were placed in the medium, which was either Earle's saline or the synthetic medium No. 199 of Morgan *et al.*[2]; in some cases 1 μgm. of hydrocortisone had been added to the medium. The culture flasks were closed with tight-fitting rubber caps, and kept at 38° C. At two-day intervals, the fragments were removed from the flasks, washed in Earle's solution, and replaced in fresh medium. Cultures were maintained up to five days, by which time the donor embryos would have hatched.

Within a few hours after being cut, the fragments healed into rounded masses with the musculature inside and the villi covering most of the surface. In all test media the villi developed normally during the first forty-eight hours; but during the following day the villi in the saline alone shortened and disappeared, so that the fragments frequently came to be covered by a smooth layer of cuboidal epithelium. In the synthetic medium, similar changes occurred, though more slowly. In both media, however, when 1 μgm. of hydrocortisone was added, long villi persisted to the end of the experiments; but the epithelial cells covering these villi, though columnar, did not differentiate so far as they would have *in vivo*, seeming rather to be arrested at the nineteen-day condition.

At daily intervals some cultures were used for weight, nitrogen and phosphatase determination, or for fixation. Weighing was done on a torsion balance of 30 mgm. capacity; in this operation all fragments from one half-duodenal loop were picked up with fine forceps and placed on an aluminium weighing pan from which excess fluid was blotted up on tiny filter-paper sponges. Although it was not possible to show how the weight of any individual culture changed, comparison of the weights of terminal cultures with weights of equal numbers of uncultured sixteen-day fragments indicated that there is a steady decrease in weight, the greatest loss occurring in the first twenty-four hours. By twenty-one days the cultured fragments had apparently lost about half their initial weight. Both gross and histological

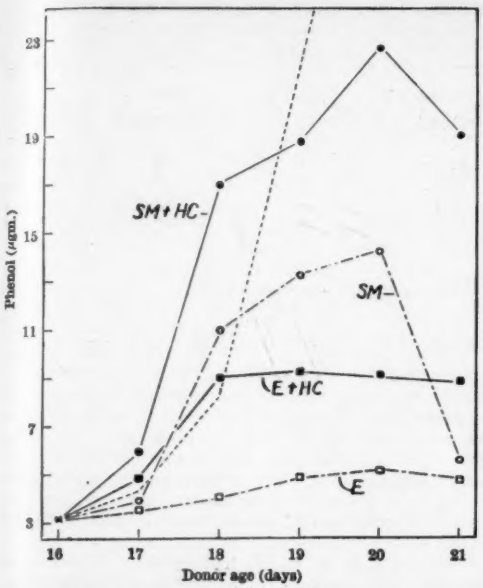

Fig. 1. Accumulation of phosphatase in fragments of sixteen-day chick embryo duodenum cultured in fluid. Enzyme activity is expressed as micrograms of phenol liberated by 1 mgm. of fresh tissue in 30 min. *SM* = synthetic medium; *E* = Earle's saline; *HC* = hydrocortisone; each point is the average value of 8–14 cultures; the dotted line represents the increase of phosphatase *in vivo*

appearance suggested that this change was not due to the loss of water.

After weighing, the fragments were ground in an all-glass homogenizer of 5 ml. total capacity. The homogenate was diluted to 3–5 mgm./ml., and an aliquot used for determination of total nitrogen. In contrast to the steady increase in duodenal nitrogen *in vivo* between sixteen and twenty-one days[3,4], the nitrogen concentration *in vitro*, under all test conditions, showed no detectable change, remaining at about 1·2 per cent of fresh weight.

Phosphatase activity was determined on phenylphosphate, quantities being scaled down where necessary to one-quarter of those usually employed[3]. In saline medium alone, it appears that phosphatase rises to a negligible extent (Fig. 1); but if hydrocortisone is added, the enzyme increases at the normal rate to the eighteen-day level, thereafter remaining unchanged. In synthetic medium alone the rate of increase is even faster, and in synthetic medium plus hydrocortisone the rate is twice as fast as *in vivo*. In both cases, however, the rate slackens after the donor age of eighteen days, and finally there is an absolute loss of enzyme, the loss being most severe in the cultures without hormone, in which the villi have usually disappeared by the twenty-first day. This slackening of rate and subsequent decline of enzyme content could not be prevented either by filling the culture vessels with 95 per cent oxygen/5 per cent carbon dioxide, or by removing waste carbon dioxide by means of a small quantity of 10 per cent potassium hydroxide placed in a centre well in the culture vessel.

Duodenal fragments from embryos of twelve, fourteen and seventeen days have also been raised in culture. All these respond to synthetic medium and to hydrocortisone in much the same way as the sixteen-day tissue, except that at the earlier stages the response to the hormone is somewhat delayed, as it is *in vivo*[4]. Eighteen-day tissue did not survive for more than twenty-four hours under the conditions employed.

Although the duodenal fragments do not increase in mass in the fluid cultures, it is evident from the patterns of phosphatase accumulation that they do utilize some of the substances of small molecular weight contained in the synthetic medium. Whether it is the amino-acids that are utilized, or other materials, is not yet known. That some essential factors are still lacking, however, is shown by the failure of differentiation and phosphatase accumulation to be carried beyond the normal nineteen-day level. The missing factors are not found in fowl serum or ten-day embryo extract, for the previously mentioned cultures that were raised on plasma and extract showed the same nineteen-day arrest of phosphatase increase, and subsequent decline, as did those in synthetic medium. Possibly the very great differentiative changes that occur in the intact duodenum after nineteen days, but have not yet been duplicated in culture, reflect the synergistic action of other hormones with adrenocorticoids.

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Formation and Radiosensitivity of Myoglobin

HÆMOGLOBIN is laid down in the maturing erythropoietic marrow cells. Exposure to ionizing radiation depresses the formation of new erythropoietic marrow cells and may destroy any such cells already present. Anæmia resulting from this interference manifests itself after the lapse of some days in a reduced erythrocyte count and reduced hæmoglobin content of the circulation. It becomes visible after the lapse of a few hours through a reduced incorporation of administered radio-iron into the circulating red corpuscles[1–3].

To investigate if, in addition to interference with the *milieu* in which the hæmoglobin is laid down, irradiation interferes with hæmin formation *per se*, we have investigated the effect of exposure to radiation on the formation of such hæmins as, for example, cytochrome *b* of the liver, which are not formed in connexion with mitotic processes. Doses up to 1,300 r. were found not to reduce the incorporation of iron-59 into cytochrome *b*. We found[4], however, that incorporation into myoglobin of muscles

Table 1. Effect of Exposure to 500 r. of X-rays on the Incorporation of Iron-59 into Hæmoglobin and Myoglobin

	Time in hr.		Specific activity					
	Between exposure and injection	Between injection and termination of life	Hæmoglobin			Myoglobin		
			Control	Irradiated	Irradiated / Control	Control	Irradiated	Irradiated / Control
Guinea pigs	6	18	100	20	0·20	42	18	0·43
			100	22	0·22	22	10	0·45
			100	28	0·28	18	7	0·39
Rats	6	66	100	49·0	0·49	19·8	12·5	0·63
	6	66	100	49·3	0·49	18·4	10·7	0·58
	23	46	100	8·9	0·09	16·1	2·67	0·16
	23	46	100	5·1	0·05	15·0	1·52	0·10

49 per cent of injected iron-59 incorporated in the course of 66 hr. into hæmoglobin

extracted from eighty guinea pigs and thirty rats injected with 1–5 μgm. of iron-59 of an activity of 1–4 μc. administered intraperitoneally as citrate was very markedly, and to a similar extent, depressed on incorporation into hæmoglobin.

Not only is the effect of irradiation on myoglobin formation very similar to that on hæmoglobin formation, but also it fully manifests itself only after a time interval of about a day, as does its effect on hæmoglobin formation. It was observed by Hennessy and Huff[1] and others that maximal depression of incorporation of radio-iron into the red corpuscles is observed only about one day after exposure of rats to a dose of a few hundred röntgens. The following explanation is suggested for this time-lag of the radiation effect.

The laying down of hæmoglobin in erythropoietic cells takes place, as shown by Thorell[6], more pronouncedly in the later phase of maturation of erythroblasts than in earlier ones. In autoradiographic studies on iron-59 turnover by erythroid cells in rat bone marrow, Austoni[7] found the percentage of labelled cells in anæmic rats 3 hr. after administration of iron-59 to be for pro-erythroblast cells 37, the corresponding figures for basophilic, polychromatic and orthochromatic erythroblasts being 82, 94 and 90, and for the mature red cells 7. So long as viable normaloblasts with an incomplete hæmoglobin content are present in the bone marrow, the laying down of iron-59 into hæmoglobin will go on in the exposed organism. Only after these cells have left the bone marrow, which takes about a day, will the full effect of exposure to radiation manifest itself in much reduced incorporation figures of iron-59 into hæmoglobin of the circulation. Mitosis and hæmoglobin synthesis are not necessarily correlated, though, of course, blockage of mitosis and degeneration of cells will inevitably lead to failure of formation of further hæmoglobin.

In Table 1 is seen the effect of exposure to 500 r. of X-rays on incorporation of iron-59 into myoglobin prepared according to Theorell and Åkeson[5] and also into hæmoglobin.

A mitotic figure of 3 found in the bone marrow of the rat[8], amounting to about 1 per cent of the body-weight, suffices to keep up the normal hæmoglobin level, that is, to replace the erythrocytes which have terminated their life-cycle. As the myoglobin content of the rat[9] amounts to 1/32 only of that of its hæmoglobin content, its muscles are 46 per cent of body-weight; and as we find by comparing the specific activity of myoglobin and hæmoglobin iron that the life-time of the myoglobin is about four times longer[10] than that of hæmoglobin, a nuclear division figure (muscle nuclei are said to divide mainly in an amitotic way) of $\frac{1}{32 \times 4 \times 46} = \frac{1}{5,888}$ only of that observed in the bone marrow should suffice to keep up the normal myoglobin level. Measurement of such a low nuclear division figure by the usual histological methods may encounter very great difficulties. Text-books of histology do not contain any account of the building up of myoglobin. The above consideration strongly suggests that this compound is laid down in the course of maturation of cells of the muscle tissue in a manner similar to that in which hæmoglobin is laid down during the maturation of erythropoietic cells of the bone marrow.

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Modulating Action of the Thyroid on Œstrogen-induced Pituitary Tumours in Rats

The capacity of œstrogen to induce tumours of the pituitary gland in the intact rat is well known, although the mechanism whereby these tumours are consistently produced remains unsolved. In the present investigation, it is shown that the thyroid gland, at least, plays an important part in modifying the incidence of hyperplasia and tumour formation of the pituitary gland induced by prolonged treatment with œstrogen.

A total of 184 adult albino rats of the Wistar strain were used for the various experiments set out in Table 1. Œstrogen was made available to 173 of these rats in the form of single pellets of œstradiol benzoate, weighing 6–8 mgm. and implanted sub-

Table 1

	A			B			C			D			E			F		
	Œstradiol benzoate only			Œstradiol benzoate + thyroxin			Œstradiol benzoate + thiouracil			Œstradiol benzoate + thyroidectomy			Œstradiol benzoate + dietary restriction			Thiourea only		
Duration of experiment (days)	Range of pituitary weights (mgm.)	Average weight of pituitary (mgm.)	No. of rats	Range of pituitary weights (mgm.)	Average weight of pituitary (mgm.)	No. of rats	Range of pituitary weights (mgm.)	Average weight of pituitary (mgm.)	No. of rats	Range of pituitary weights (mgm.)	Average weight of pituitary (mgm.)	No. of rats	Range of pituitary weights (mgm.)	Average weight of pituitary (mgm.)	No. of rats	Range of pituitary weights (mgm.)	Average weight of pituitary (mgm.)	No. of rats
1– 50	15– 45	30	8	15– 50	29	7	20	20	1									
51–100	34– 94	53	4	71–302	138	9	6–46	21·3	13									
101–150	28–405	217	8	179, 273	226	2	19–34	24·8	7	29	29*	1	9–13	9	3	8–10	9	7
151–200	46–434	275	24	173–602	398	9	23–73	42·1	7	19, 19	19	2	8–41	22	5			
201–250	164–442	311	28				21–68	36·5	8				31, 40	36	2			
251–300	145–359	281	16										11–20	16	3	9–17	14	4
301–350	214–364	266	5							55	55*	1						
Total No. of rats			93			27			36			4			13			11

* Thyroid fragment present.

cutaneously. Thiourea and thiouracil were fed at a 0·5 per cent level in the stock ration[1]. To avoid acute pulmonary œdema known to occur after the inclusion of 0·5 per cent thiourea in the diet, the drug was fed in graded amounts, starting at a level of 0·01 per cent and gradually increasing to 0·5 per cent. Thyroxin was injected subcutaneously three times a week in doses of 20 μgm. A group of thirteen rats, implanted with pellets of œstradiol benzoate, were fed half the amount of the stock ration consumed by rats also bearing a pellet of œstradiol benzoate. The rats on the reduced ration lost weight for the first month, and then maintained their weight until a few weeks before they died or were killed when moribund.

Œstradiol benzoate promotes a steady enlargement of the pituitary gland in normal adult rats (Table 1, *A*). The glands may become so large that the hypothalamus and related parts of the brain may be compressed. Although pituitary enlargement can be detected in some rats by the 50th day, the gland may have increased forty-fold in weight between the 100th and 150th day.

The administration of thyroxin accelerates the development of pituitary tumours and leads to premature death of the rats (Table 1, *B*). The pituitary glands exceeded 400 mgm. in weight in five of the group of nine rats treated with thyroxin and dying between the 150th and 200th day, whereas in the group not receiving thyroxin only two pituitaries exceeded 400 mgm. at a corresponding stage of the experiment (Table 1, *A*).

In striking contrast, the pituitary gland showed only mild hyperplasia in rats bearing an œstrogen pellet but fed thiourea or thiouracil (Table 1, *C*). The heaviest gland in this group of rats did not exceed 73 mgm. Although only two of the six thyroidectomized rats treated with œstrogen survived beyond the 100th day, there was sufficient evidence that thyroidectomy also prevented the enlargement of the pituitary gland (Table 1, *D*). Even partial thyroidectomy seemed to counteract the effect of œstrogen.

Dietary restriction inhibited pituitary enlargement as effectively as did the feeding of antithyroid drugs (Table 1, *E*).

On the basis of these observations, it can be concluded that depression of thyroid function, following either the administration of thiourea or thiouracil, or a reduction in food consumption, inhibits pituitary hyperplasia and tumour formation in œstrogen-treated rats, whereas thyroxin has the reverse effect. It is suggested that any set of circumstances which leads to a depression of metabolism will modify the action of œstrogen on the pituitary gland. It is furthermore evident that a functionally active thyroid gland is indispensable for the development of pituitary tumours.

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Effect of Potassium Ions on Brain Slices

WE have already analysed the ammonia formation systems in brain tissue as part of a study of the metabolic patterns of the excitatory state in the nervous system[1]. We have now extended our investigation to the respiratory and energy-transfer systems. It is well known that both the respiration and lactate formation of brain slices are markedly increased by the addition of potassium chloride, and a similar condition is also induced by electrical stimulation of brain slices[2].

Slices of guinea pig cerebral cortex were used, and their oxygen uptake was measured in Krebs–Ringer solution containing 0·2 per cent glucose or other substrate by the usual manometric technique at 37° C. Lactate was determined chemically by the method of Barker and Summerson.

First we examined the role of sodium ions in the potassium effect. The extra oxygen uptake caused by potassium chloride was completely inhibited in solutions in which sodium was reduced to less than 15 m*M* by choline. Lactate formation was increased significantly in sodium-free medium and was not changed further by the addition of potassium chloride. But the effect of 2-4 dinitrophenol (5×10^{-5} *M*) on the respiration of brain slices was not influenced by

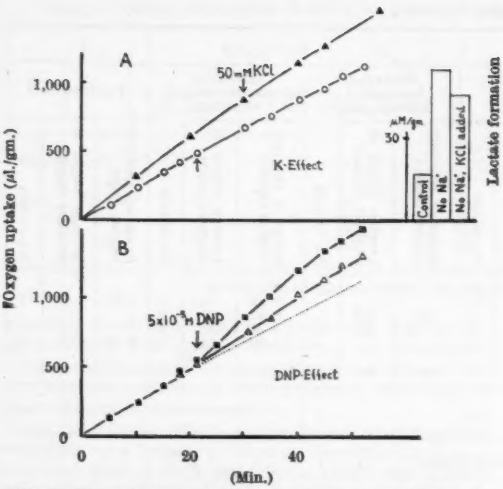

Fig. 1. Sodium ion concentration and potassium- or dinitrophenol-effect when glucose (0·2 per cent) is the substrate.
(*A*) Potassium effect: ▲, 15 m*M* sodium ions; ○, no sodium ions. Right, aerobic lactate formation during 1 hr. incubation under conditions of no sodium ions.
(*B*) Dinitrophenol effect: ■, 15 m*M* sodium ions; △, no sodium ions

sodium ion concentration, and in sodium-free medium it clearly increased the oxygen uptake. These relationships were similarly observed with pyruvate (10 m*M*) as a substrate, though lactate formation was slight and not increased by potassium chloride or 2–4 dinitrophenol.

The observation of Kimura and Niwa[3] that only the extra oxygen uptake due to potassium chloride is completely inhibited by malonate was confirmed, and, when fumarate or oxalacetate was added further, the potassium effect was clearly observed in spite of the presence of malonate.

Table 1

Substrate	Inhibitor	Oxygen uptake (*μM*/gm./hr.)			
		Inhibitor absent		Inhibitor present	
		Control	KCl added	Control	KCl added
Pyruvate, 1 m*M*	Malonate, 10 m*M*	64·5	105	61·6	67·3
Lactate, 5 m*M*	,,	61·0	100	—	63·9
Glucose, 0·2 per cent	,,	55·0	—	52·1	56·0
Glucose, 0·2 per cent, plus oxalacetate, 10 m*M*	,,	69·2	—	72·0	102
Citrate, 10 m*M*	Fluoro-citrate	57·0	—	41·3	—
Pyruvate, 1 m*M*	,,	56·1	96·9	56·5	78·0
Glucose, 0·2 per cent	Azide, 1 m*M*	54·5	106	56·2	61·9

Heald[4] reported that the increased oxidation of lactate in response to electrical impulses is not affected by malonate. But the increased oxidation of pyruvate or lactate by potassium chloride was also inhibited by malonate, when the substrate concentration was reduced to 5 m*M* in lactate and to 1 m*M* in pyruvate. Moreover, fluorocitrate, a potent inhibitor of citric dehydrogenase, which was prepared enzymatically, inhibited only the increased respiration due to potassium chloride; sodium azide (1 m*M*) also had the same effect.

These findings make it likely that respiration activated by potassium chloride is different in nature from normal respiration and that it involves the operation of the citric acid cycle. But the consumption of glucose in the respiring medium by brain slices, which was determined chemically using the method of Nelson, was strikingly inhibited by malonate, although changes in oxygen uptake and lactate formation were not detected. In the potassium effect, glucose consumption was also inhibited by malonate and lactate formation was further increased. It shows that the endogenous respiration takes a chief part in the observed oxygen uptake when the citric acid cycle is blocked in brain slices, and that the citric acid cycle operates also in normal respiration.

Table 2

Condition KCl (70 m*M*)	Condition Malonate (10 m*M*)	Glucose consumption (*μ*mole/gm.)	Lactate formation (*μ*mole/gm.)	Oxygen uptake (*μ*mole/gm.)
—	—	35·9	34·9	54·1
—	+	4·71	28·0	61·5
+	—	112	99·0	104
+	+	63·7	117	44·9

Influence of malonate on the glucose consumption and lactate formation in presence and absence of potassium ion effect. Glucose, initially 2·8 m*M*; gas phase, air. Duration, 80 min.

Next we studied the content of phosphocreatine in brain slices in the presence of malonate. Inorganic phosphate was measured under the conditions of Lowry and Lopez[5], phosphocreatine determined by the differential stability as described by Bailey and Marsh[6]. As the incubation medium, 0·05 *M* glycyl-glycine buffer Ringer solution was used.

Table 3. Content of Inorganic Phosphate and Phosphocreatine

Medium	KCl added	Inorganic phosphorus *μ*mole/gm.		Creatine phosphorus *μ*mole/gm.	
No glucose	—	5·50		0·36	
Glucose, 0·2 per cent	—	3·20	3·00	0·86	1·03
Glucose, 0·2 per cent	+	6·16	4·62	0·03	0·18
Glucose, 0·2 per cent plus malonate, 10 m*M*	—	3·16	3·00	0·82	0·75
,,	+	4·48	4·56	0·13	0·22

In the presence of malonate, the amounts of phosphocreatine and inorganic phosphate in brain slices after 40 min. incubation were not altered significantly, and the sudden fall of phosphocreatine through addition of potassium chloride was similarly observed.

From these results it is considered that potassium ions may affect two enzymatic points, one of which is the glycolytic system and the other the pyruvate oxidation system, probably the condensing enzyme. It is of interest that the level of phosphocreatine in brain slices still remains high in spite of the complete inhibition of the citric acid cycle by malonate.

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An Improved Technique for staining Blood Films with Giemsa Stain

During recent years, the thick-film method of searching for malaria and other blood parasites has largely displaced thin films, especially in what are called 'field surveys' where hundreds and even thousands of blood films may have to be examined. The stain most used is Giemsa (1 c.c. of stain to 15 c.c. of distilled water). Films are stained by immersion for 20 min. in the diluted stain without previous dehæmoglobinization. While this method gives reasonably good results, it has the disadvantage of deeply staining the envelopes of the erythrocytes which adhere to the slide, even though they have lost their hæmoglobin.

If normal saline (0·85 sodium chloride) which has been buffered to *p*H 7·4 is used instead of distilled water, and the films stained for 30 min., staining is greatly improved. The background is clean because the envelopes of all uninfected cells have been removed. On the other hand, the parasitized cells remain, and in *P. vivax* infections Schuffner's stippling is sharply stained and therefore makes species diagnosis easy.

Giemsa stain diluted with normal saline also improves the picture in thin films; it not only reduces the dense appearance of the normal cells but also improves the stippling and shows up the parasites more strikingly. But it is especially for thick films that this improved technique is likely to be most helpful.

Field's technique gives a cleaner background than does Giemsa diluted with distilled water; but by his technique each film has to be stained separately, whereas by the technique quoted above films can be stained in bulk with good results.

The reason for the improvement may be that saline has the effect of dissolving out any globulin and that hæmoglobin in this behaves like a globulin. For solution globulin requires salt solution, and is not soluble in plain water; so it seems possible that in the ordinary way with distilled water more globulin and perhaps even some of the hæmoglobin remains unremoved and so gives a darker staining effect.

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Effect of Crystalloid Solutions prepared in Glass Bottles on Human Red Cells

Various serological techniques employed in blood grouping and allied work involve the washing of human red cells with isotonic solutions, often of saline or sodium citrate.

When carrying out the anti-globulin test[1], it is necessary, after the test cells have been incubated with the serum which may contain a blood-group antibody, to wash them until they have been separated from the serum and are freely suspended in saline. While this washing was being carried out, the cells occasionally became spontaneously agglutinated. This occurrence was observed irregularly, and the strength of the non-specific agglutination was variable. On one occasion, for example, the first washing with an isotonic saline solution produced no agglutination; but subsequent washing produced a very strong and marked agglutination of the red cells. On most other occasions minor agglutination occurred. In the later stages of the test, the washed red cells are mixed with the diluted antiglobulin reagent upon a microscope slide and stirred with either another glass slide or a glass tube; weak false positive results occurred from time to time. Sometimes, when the antiglobulin reagent was being titrated on a tile and stirring of the test cells and diluted reagent was carried out with a small test tube or the tip of a microscope slide, it was observed that weak positive results were obtained in the higher dilutions and in the control test.

Recent techniques have enabled red cells to be frozen solid, and the method of Chaplin and Mollison[2] has been used for enabling test cells, and particularly those of rare blood groups, to be stored so that they can be used whenever required in the laboratory. In order to bring these cells from their suspension in glycerol into a saline solution, they may be treated by washing in successive concentrations of trisodium citrate solution. It was noticed from time to time that non-specific agglutination occurred during the washing of these cells with citrate solutions.

The common factor in all these observations was that agglutination of washed cells occurred only in the absence of serum or when its concentration was very low; trisodium citrate solutions were particularly troublesome.

Extensive investigations were carried out in order to determine the cause of the phenomenon, and it was concluded that the presence of glass was an essential feature. If trisodium citrate solutions are autoclaved in glass containers and afterwards frozen, a solution showing strong agglutination of washed erythrocytes is frequently obtained. If the solution is autoclaved in containers of various different glasses, the strength of the effect varies. If the solutions are autoclaved in plastic bags, no agglutination of the washed cells is observed. Similarly, if the solutions are sterilized by Seitz filtration there is no red-cell agglutination.

A similar agglutination of washed erythrocytes can be brought about by placing the washed cell suspension on a microscope slide, stirring vigorously with a glass rod or the corner of another slide and rocking gently. This phenomenon is also inhibited by serum, but is not always completely inhibited by the low concentration of serum in a dilute antiglobulin reagent. This phenomenon seems to be related to the abrasive action of the two glass surfaces on stirring, and it can be avoided by stirring with a soft plastic rod. This effect is a not infrequent cause of difficulties in the last stage of the antiglobulin test.

It seemed to us, from these experiments, that glass (or some component of glass) was responsible for these phenomena, and following consultations with various chemists and physicists (particularly Mr. D. C. Henry, of the University of Manchester) a solution of colloidal silica was prepared.

It was found that a very dilute solution of silica sol would cause an intense aggregation of normal red cells suspended in saline, but aggregation was absent if the red cells were suspended in serum. Activity was still present at very low concentration of silica, for example, of the order of one part per million. Only certain preparations of silica sol showed the phenomenon, and the factors involved in this are being investigated further.

The amount of protein that was required to prevent the agglutination of the cells depended upon the sol that was used. If a very strong one was employed, human serum diluted 1 : 4 would not prevent the agglutination of washed red cells.

Since it appears that silica (presumably in colloidal solution) can be derived from glass by treatment with water, particularly at a high temperature or at alkaline *p*H, it seemed that a silica sol might be formed under the conditions previously described, and it was concluded that false positive results might be caused in the antiglobulin test and in other serological techniques by the presence of silica sol in the crystalloid solutions that had been prepared for these tests. The physical aspect of this phenomenon is complicated and it is not proposed to discuss it here.

From a practical point of view, therefore, crystalloid solutions which are to be used for the washing of red cells should not be prepared by autoclaving in glass bottles, nor should they be frozen in glass bottles; but if they have to be heated they should be heated in plastic bags, or sterilization achieved by Seitz filtration; alternatively, solutions may be made up freshly without sterilization or freezing. The ease with which citrate solutions become infected makes it desirable, however, that they should be sterilized by some means; and we, ourselves, use Seitz filtration, making up small quantities which are used only once.

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The N-Terminal Amino-Acid of Rabbit Gamma-Globulin and Antibody

Porter[1] found that both the anti-ovalbumin antibody and the non-specific γ-globulin of rabbit serum contained the same single N-terminal amino-acid, namely, alanine. Hughes and Sinex[2] consider this "amazing"; and seeing that the serum component called γ-globulin is a family of proteins that includes diverse antibodies and possibly protein with other functions, and has been shown to be heterogeneous by various physico-chemical criteria, this result is certainly not inevitable.

The N-terminal amino-acid of another rabbit antibody—that against bovine serum albumin—has now been determined together with the end-group of 'inert' rabbit γ-globulin. The method used was the fluorodinitrobenzene method of Sanger[3] with paper chromatography (phthalate *tert.*-amyl alcohol) for identification of the dinitrophenyl amino-acids.

The specific precipitate was found to possess one N-terminal alanine per molecule of 156,000. Aspartic acid, corresponding to one residue per molecule of the bovine serum albumin (mol. weight 69,000) in the precipitate, was also recovered. The non-specific γ-globulin yielded 0·91 mol. of alanine/molecule of 156,000 molecular weight; aspartic acid (corresponding to 0·2/mol.) was also found. Even though no serum albumin could be detected in the original γ-globulin preparation by paper electrophoresis, it is possible that this aspartic acid came from contamination with rabbit serum albumin, in quantities too small to be detected by electrophoresis, that is, less than 5 per cent. Less than 5 per cent of serum albumin in the γ-globulin preparation would suffice to account for the aspartic acid found.

Table 1

γ-Globulin	Asp.	Glu.	Ser.	Ala.	Val.	Thr.	Leu, Ileu.
Human II—1, 2 (ref. 5)	1·06	1·82	0·10				
Human II—3 (ref. 5)	1·01	1·06	0·17				
Human II (ref. 4)	1·0	1·0	0·1–0·2				
Human myeloma (ref. 4)	2·0						
Bovine (ref. 5)	0·13	0·15	0·09	0·09	0·11		
Horse (ref. 5)	+	+	+			+	+
Rabbit non-specific	0·2			1·0 (ref. 1) 0·91			
Rabbit, anti-Ea (ref. 1)				1·0			
Rabbit, anti-bovine serum albumin				1·0			

These findings confirm Porter's. The γ-globulins of all other species investigated so far, differ from that of the rabbit in having more than one terminal amino-acid per molecule and appearing to be more heterogeneous, in that different fractions of the same γ-globulin have different end-groups. In addition to the species listed in Table 1, Porter[4] found that pig γ-globulin contains six free α-amino groups. Smith[7] reports an increase of N-terminal valine in the 'immune globulins' of cattle; these immune globulins, however, are merely fractions containing unknown amounts of antibody, whereas the specific precipitates used by Porter and myself for antibody end-group determination were 90 per cent antibody.

Since antibodies against two different antigens and 'non-specific' γ-globulins (which may include a variety of antibodies) have the same single terminal amino-acid (in the rabbit), it is improbable that this part of the molecule is involved in either of the specific combining groups of the antibody molecule.

I wish to thank Dr. F. Sanger for his help and advice, and for letting me use the facilities of his laboratory.

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Cup-plate Assay of Serum Fibrinolysin

In recent years, attention has been given to the quantitative estimation of serum fibrinolysin. Study of the plate test of Permin[1] indicated that some modification of this method was necessary to estimate numerous unknown enzyme samples. The cup-plate assay method described by Dingle, Reid and Solomons[2] seemed suitable, since it was designed to estimate large numbers of samples over a wide range of enzyme concentrations. We have found that a combination of the principles of these two methods is applicable to the measurement of serum fibrinolysis.

A 0·5 per cent solution of fibrinogen in sodium barbitone – hydrochloric acid buffer *p*H 8·0 was prepared and kept in a water-bath at 43°. A 4·0 per cent solution of agar in buffer was prepared and cooled to 53°. Equal quantities of these two solutions were mixed with gentle stirring and poured quickly on to an accurately levelled glass sheet, which was bounded by a sealed frame of requisite dimensions. The total volume used was that required to give a final plate depth of 3·25–3·5 mm. After the gel had set, buffered thrombin (Maw) was applied evenly to the gel surface (one 10 ml. thrombin ampoule for a plate area of 1,000 sq. cm.). The plate was then incubated in a humid atmosphere at 37° for two hours, the gel becoming opalescent due to the precipitation of the fibrin in a finely divided form. Excess thrombin was removed, the requisite number of cups were cut with a cork borer of 8 mm. diameter, and filled with 0·1 ml. of enzyme solution. An assay design similar to that of the antibiotic cup–plate assays was used. Most of the findings of Brownlee *et al.*[3] were relevant.

The plate was incubated for 18 hr. and measurement was carried out by projecting the lysed zones on to a ground-glass screen. The zone was read by taking the mean of two diameters; with a magnification of 5, the usual range of diameters was 60–100 mm., and the variation between a number of zones of identical enzyme concentration was 2 mm. We have found that with a substrate concentration of 0·25 per cent there is a linear relationship between the logarithm of enzyme concentration and the square of the zone radius over a wide range of enzyme concentrations (Fig. 1).

A sodium barbitone – hydrochloric acid buffer was used, since it gave good *p*H stability during a prolonged period of enzymatic hydrolysis. The *p*H optimum curve under these conditions shows a sharp peak at *p*H 8·0 with 50 per cent loss in activity at *p*H 9·0 and 90 per cent loss at *p*H 6·5.

Estimation of serum antifibrinolysin was carried out by prior incubation, for 2 hr. at 37°, of various serum dilutions with a standard enzyme preparation. The resulting activity was expressed as a percentage of the control, and was inversely proportional to the logarithm of the serum concentration between final serum concentrations of 1/3·5 and 1/35.

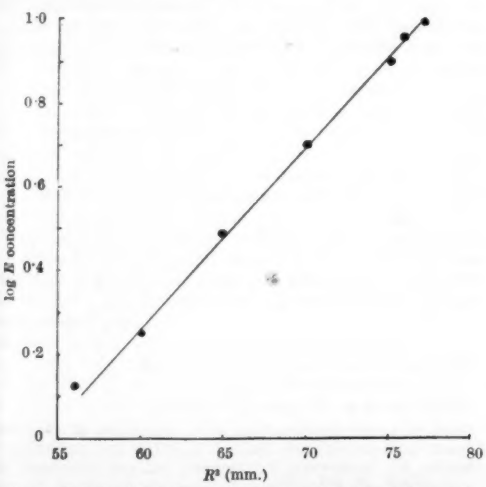

Fig. 1. Relationship between the square of the zone radius and the logarithm of the enzyme concentration

The main advantage of this method is that it is possible to measure numerous enzyme samples under identical conditions. Care must be taken in the choice of commercial fibrinogen preparations, as some batches have an appreciable amount of profibrinolysin adsorbed. Although this does not affect the area lysed by an enzyme preparation, it causes a loss of contrast at the zone edge and consequent difficulty in reading.

We wish to thank Dr. G. D. Kersley for his advice and encouragement.

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Colour Reagent for Paper Chromatography of Steroids

For the paper chromatography of steroids several colour reagents are used, such as 2,4-dinitrophenylhydrazine, Zimmermann's reagent, phosphomolybdic acid, antimony trichloride, etc. Their common defect is that the reagent gives some colour with the paper itself, and so the contrast between spot and paper is too small. We have found that acid aniline phthalate in alcoholic solution—the reagent Partridge used for tracing sugars[1]—is suitable for the indication of steroids as well. On the white background the steroids show as yellow, orange or brown spots.

The sensitivity of the reaction is increased about ten times when *p*-phenylendiamine is substituted for aniline. 2–3 μgm. of steroid gives good, easily distinguishable spots. The reagent is, as shown in Table 1, rather selective. Only steroids containing the Δ4-3-keto-group in the *A* ring show any colour reaction.

Table 1

Reichstein's compound 'S'	+	reddish-brown
Progesterone	+	" "
6,11-Dyhydroxyprogesterone	+	" "
11α-Hydroxyprogesterone	+	" "
Pregnane-3,20-dione	−	
Allopregnane-3,20-dione	−	
Pregnane-3α-ol-20-one	−	
Allopregnane-3β-ol-20-one	−	
Testosterone	+	orange
Δ4-Androstene-3,20-dione	+	reddish-brown
5-Dehydroandrosterone acetate	−	
Progesterone-20-cyanhydrine	+	brown
Δ5-Pregnene-3-ol-20-one	−	
Δ5,16-Pregnadiene-3-ol-20-one	−	
Δ4,16-Diene-3,20-dione	+	yellow
*iso*Ergosterone	+	orange
Δ4,22-Ergostadiene-3-one	+	brown
Δ22-Coproergostene-3-one	−	
22,23-Dibromergost-8-ene-11-one-3-acetate	−	
Δ1,4-Adrostadiene-3,20-dion	+	yellow

The colour reaction can be carried out with oxalic acid in place of phthalic acid, or with α- or β-naphthylamine in place of aniline.

Use of the new reagent led us to the interesting observation that chloroform solutions of progesterone and 11α-hydroxyprogesterone gave after some weeks of standing a much stronger colour reaction than fresh solutions. In such solutions a new compound was formed—perhaps by oxidation—which could be

shown by paper chromatography (in a propylene glycol–toluene system) as a very slowly moving spot.

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Detection of Iodine-containing Compounds on Paper Chromatograms

Bowden, Maclagan and Wilkinson have described[1] the use of the ceric sulphate – arsenious acid reaction for the detection of micro-quantities of iodine-containing compounds on paper chromatograms. A difficulty encountered in this laboratory was the fading of the background colour due to the presence of traces of iodine in the atmosphere. This can be prevented by spraying the chromatograms, immediately on completion of the catalytic reaction, with a 1 per cent solution of *o*-phenylenediamine in acetone and drying in air. The stable chocolate-coloured background formed by reaction of excess ceric sulphate with the amine gives a greatly increased contrast with the white spots, and the life of the chromatogram is limited only by the decomposition of the cellulose by the acid present in the original reagent.

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The System Niobium–Silicon and the Effect of Carbon on the Structures of Certain Silicides

The phase diagram of the niobium–silicon system has been established by melting-point determinations, X-ray examination and metallography, and is shown in Fig. 1. Alloys were prepared in the form of beads weighing 1–2 gm. by melting the constituents together in an argon arc-furnace[1]: the metals used were 'Matthey' standards and the silicon was Johnson, Matthey and Co.'s 'Hyperpure'. Melting-point measurements were made in the furnace by a technique described earlier[2].

Three intermediate phases, Nb_4Si, Nb_5Si_3 and $NbSi_2$, are present in the system. That of composition Nb_4Si is formed peritectically at about 1,950° C. from Nb_5Si_3 and the melt. From metallographic and X-ray examinations, it is evident that this compound is isomorphous with Ta_4Si and Zr_4Si, but the DO_{19} structure of the Ta_4Si phase reported by Kieffer, Benesowsky, Nowotny and Schachner[3] has not been detected in alloys arc-melted from components of high purity. The phase Nb_5Si_3 melts congruently at 2,480° C., and exists in two modifications, 'α-Nb_5Si_3' stable at low temperatures, and 'β-Nb_5Si_3' the high-temperature phase. The α–β transformation lies between 1,900° and 2,100° C. Phases with structures corresponding to α- and β-Nb_5Si_3 have been found in systems of silicon with the neighbouring transition metals of Groups IV, V and VI. Powder photographs of arc-melted specimens of V_5Si_3, Cr_5Si_3, Mo_5Si_3 and W_5Si_3 suggest that these compounds are isomorphous with the β-form of Nb_5Si_3, and that arc-melted Ta_5Si_3 is isomorphous

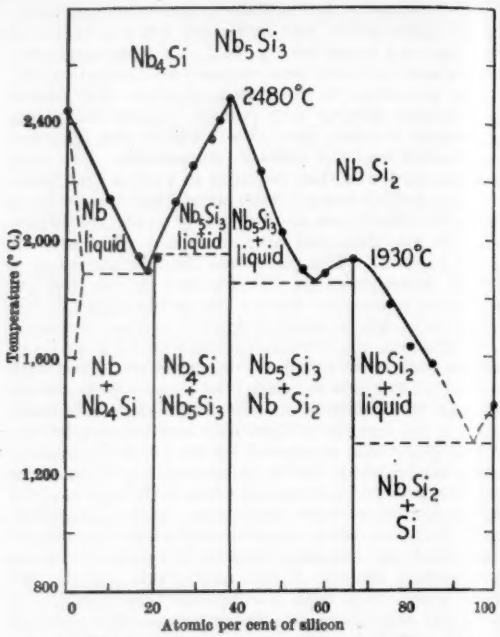

Fig. 1. Niobium – silicon system. •, Observed melting points

with the α-form. In an investigation of alloys prepared by hot-pressing in graphite moulds, Schachner, Cerwenka and Nowotny[4] determined the structures of several silicides of the composition M_5Si_3. They reported that V_5Si_3, Mo_5Si_3 and Nb_5Si_3 had the $D8_8$ structure, but this structure was not found in the arc-melted silicides used in the present work. Carbon is a very probable contaminant in hot-pressed samples, and to determine whether carbon contamination accounts for the discrepancy in results, the M_5Si_3 silicides were re-melted in the arc furnace with 1–2 wt. per cent of coconut charcoal. In all cases the addition of carbon caused the formation of $D8_8$ structures.

The melting point of $NbSi_2$ has been determined as 1,930° C., and a eutectic is formed between this compound and Nb_5Si_3 at 1,850° C. and 58 atomic per cent silicon. At the niobium end of the diagram, silicon lowers the liquidus to about 1,880° C., the eutectic temperature between Nb_4Si and niobium. The terminal solubilities of silicon in niobium and niobium in silicon have not been investigated. An appreciable solubility of silicon in niobium is probable, a lattice expansion of $3{\cdot}299_3$–$3{\cdot}308_3$ kX. being observed in powder compacts sintered at 1,300° C.

I thank Dr. G. A. Geach for suggesting this investigation, and for his continued interest in it, and also Dr. T. E. Allibone, director of the Associated Electrical Industries Research Laboratory, for permission to publish this communication.

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Structure of the ω-Precipitate in Titanium–16 per cent Vanadium Alloy

In many titanium alloys the body-centred cubic β-phase, stable at high temperatures, can be retained on quenching. When re-heated to temperatures below 500° C., the alloys may first become hard and brittle. This has been associated with the precipitation of an intermediate phase termed ω [1].

Single-crystal X-ray work has been carried out on titanium–16 per cent vanadium alloy to determine the structure associated with the hard and brittle condition. Samples of 0·014 in. thick sheet were heated in vacuum for 2 hr. at 1,250° C. to produce crystals up to 5 mm. in diameter. The specimens were afterwards re-heated for 30 min. at 900° C. in argon and quenched in water. Some crystals were aged for 5 min. at 460° C. in molten tin, a treatment leading to high hardness and brittleness. Suitable crystals were thinned to 0·005 in. by solution in acid and orientated with [100]β vertical. Oscillation and stationary crystal photographs were obtained using molybdenum $K\alpha$ radiation.

Both the quenched and aged crystals showed diffractions in addition to those from β-titanium. The additional diffractions (presumably due to ω-precipitation) were elongated and joined by diffuse streaks in the photographs of the quenched crystals. The extra diffractions from the aged crystals were all sharp, so that the particles of precipitate would be greater than 300 A. in all directions. The additional diffractions occurred on layer lines, Fig. 1, and could be indexed on a cubic lattice with axes parallel to those of the original β-titanium, but three times as large. The indices were simplified by transforming to a hexagonal cell with $a_\omega = 4{\cdot}60$ A. and $c_\omega = 2{\cdot}82$ A., and oriented so that $[0001]\omega // [111]\beta$ and $(11\bar{2}0)\omega // (1\bar{1}0)\beta$; consequently, there are four possible orientations of ω in a given β-crystal.

Fair agreement between calculated and observed intensities was obtained with the atom positions 000, $\frac{1}{3}\ \frac{2}{3}\ \frac{1}{2}$ and $\frac{2}{3}\ \frac{1}{3}\ \frac{1}{2}$.

The relation between the structure of β-titanium and the proposed ω-structure is most easily revealed by a (111)β plane projection (see Fig. 2). Every second and third plane of β amalgamates into one plane in the ω-structure.

The spots from the quenched crystals were elongated in $<110>\beta$ directions, showing lack of periodicity in the $<11\bar{2}0>\omega$ directions. The ω-precipitate may be in the form of platelets parallel to $\{11\bar{2}0\}\omega$ and $\{110\}\beta$ planes; but the hypothesis needs further testing.

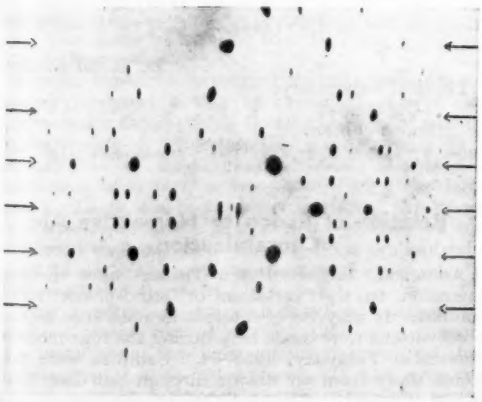

Fig. 1. Oscillation film from titanium – 16 per cent vanadium alloy aged 5 min. at 460° C. [001]β vertical; molybdenum $K\alpha$. Arrows indicate β-titanium layer lines

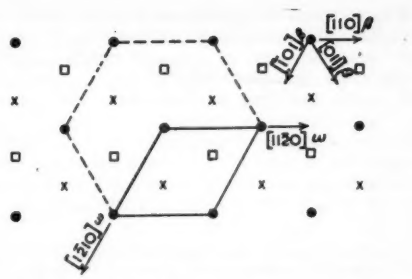

Fig. 2. Projection of atomic positions on (111)β and (0001)ω planes. The parameters of ω are $a = 4{\cdot}60$ A. and $c = 2{\cdot}82$ A.

Key:

	β	ω
	z co-ordinates	
●	0 and + 2·82 A.	0 and + 2·82 A.
×	+ 0·94 A.	× and □ + 1·41 A.
□	+ 1·88 A.	

Full details will be published elsewhere. This work forms part of the research programme of the Royal Aircraft Establishment, and acknowledgment is made of the help of Mr. H. Brooks and Dr. H. W. Rayson, of the Metallurgy Department of the Establishment, and of permission to publish granted by the Chief Scientist, Ministry of Supply.

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Equilibrium of Hydrogen-Bond Formation in the Excited State

In the course of studies on the influence of the addition of a proton acceptor upon the fluorescence of aromatic compounds, which are proton donors, we have found evidence that the excited molecules in many cases have a greater tendency to form hydrogen bonds and that a new equilibrium is reached during the life-time of the excited state. Taking β-naphthol as the fluorescent substance (proton donor), for example, we have examined the effects of the addition of several proton acceptors such as dioxane, methyl, ethyl and *n*-butyl acetate, ethyl chloracetate and others upon the fluorescence and absorption spectra and upon the intensity of fluorescence of β-naphthol dissolved in *n*-hexane.

In the case of ethyl chloracetate, a remarkable quenching of fluorescence was observed; but all the other substances cited cause the intensity to increase somewhat. Some examples showing the relative intensities, f/f_0, plotted against the concentrations of proton acceptors are shown in Fig. 1. Some changes of the absorption and fluorescence spectra characteristic of hydrogen-bond formation are, of course, observed in all cases[1].

The fluorescence and absorption of β-naphthyl methyl ether in *n*-hexane are not affected by the above substances, whereas carbon tetrachloride quenches the fluorescence of both β-naphthol and

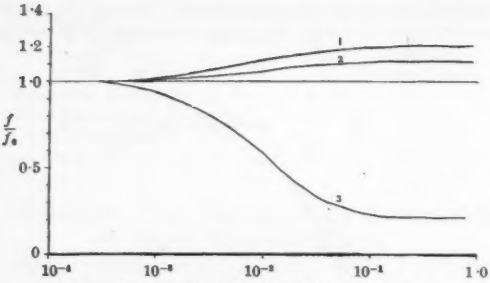

Fig. 1. Concentration effect of proton acceptors on the relative fluorescence intensity of β-naphthol in *n*-hexane (5×10^{-4} mole/l.): (1) butylacetate; (2) methylacetate; (3) ethyl-chloracetate

β-naphthyl methyl ether in the same order of magnitude. These observations show that the changes mentioned above of intensity of fluorescence are due to hydrogen-bond formation.

If the equilibrium of hydrogen-bond formation in the ground-state is not perturbed during excitation, then one may set up the following scheme for the process of fluorescence:

Process		Rate or equilibrium
$D+A \underset{k_2}{\overset{k_1}{\rightleftharpoons}} DA$		$K=k_1/k_2=[DA]/([D][A])$
$D+h\nu_a \rightarrow D^*$	light absorption	$I_{abs}[D]/([D]+[DA])$
$DA+h\nu_a \rightarrow DA^*$		$I_{abs}[DA]/([D]+[DA])$
$D^* \rightarrow D+h\nu_f$	emission of light	$k_f[D^*]$
$DA^* \rightarrow DA+h\nu_{f'}$		$k_f'[DA^*]$
$D^* \rightarrow D$	quenching process	$k_g[D^*]$
$DA^* \rightarrow DA$		$k_g'[DA^*]$

where D and A are respectively β-naphthol and a proton acceptor, and the other notations have the usual meaning.

On the basis of this scheme the following relation can easily be derived if one assumes, as in practice, that the extinctions of the wave-length of excitation of A and AD are equal:

$$\frac{f}{f_0} = \frac{1+\alpha K[A]}{1+K[A]} \qquad (1)$$

where f_0 is the intensity of fluorescence of the pure β-naphthol solution, f is that of the system containing a certain proton acceptor, and α is the ratio of the quantum yields of fluorescence in the two cases.

If, on the other hand, a new and different equilibrium state for hydrogen-bond formation is realized during the life-time of the excited molecule, then a relation similar to (1) still holds, but in this case K is related to the excited molecule. Hence in this case K obtained from the data of fluorescence intensity ($K^{(f)}$) may be different from that obtained from the absorption spectra ($K^{(a)}$), whereas if the equilibrium state is maintained, $K^{(a)}$ and $K^{(f)}$ must coincide.

Formula (1) agrees with the experimental observations very exactly. The K-values obtained from it, however, are different from those of $K^{(a)}$ obtained from the absorption spectra by the method of Rosenblatt[2].

The free energy of hydrogen-bond formation as calculated from log $K^{(a)}$ and log $K^{(f)}$ are tabulated in Table 1. Probable errors would be less than $\pm 0{\cdot}05$. Thus, in all cases $|\Delta F^{(f)}|$ is greater than $|\Delta F^{(a)}|$, and we may conclude that the equilibrium shifts toward hydrogen-bond formation to some extent during the life-time of the excited molecule.

Table 1
(in kcal./mol.)

	$\Delta F^{(f)}_{283}$	$\Delta F^{(a)}_{283}$	$\Delta F^{(f)}_{283}-\Delta F^{(a)}_{283}$
Dioxane	$-1{\cdot}6_5$	$-1{\cdot}50$	$-0{\cdot}1_5$
Butyl acetate	$-2{\cdot}8_0$	$-1{\cdot}80$	$-1{\cdot}0_0$
Methyl acetate	$-2{\cdot}4_3$	$-1{\cdot}82$	$-0{\cdot}6_3$
	$\Delta F^{(f)}_{298}$	$\Delta F^{(a)}_{298}$	$\Delta F^{(f)}_{298}-\Delta F^{(a)}_{298}$
Ethyl acetate	$-2{\cdot}0_4$	$-1{\cdot}67$	$-0{\cdot}3_7$
Ethyl chloracetate	$-1{\cdot}8_5$	$-1{\cdot}29$	$-0{\cdot}5_6$

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An Early Electric Valve

Although the Edison effect was discovered some twenty years before the thermionic valve was patented, it is perhaps not generally known that the rectification of a current by an electric valve had taken place as early as 1863.

P. Riess, in a paper entitled "On the Electrification of the Magnetic Needle by the Secondary Currents of a Leyden Battery"[1], describes the repetition of some experiments carried out originally by M. Gaudin in which "an apparatus called the electric valve" was used. The valve consisted of a glass cylinder inside which were a brass disk 25 mm. in diameter and a separate platinum wire. The distance between the disk and the point of the wire was about 2 mm. When the cylinder was evacuated, a current was found to pass through it from the plate to the wire if the pressure was "not less than 2 lines or greater than 5 inches of mercury". From his experiments Riess formulated the rule: "By means of the electrical valve, and in any position, the secondary current of the Leyden jar deflects the magnetic needle in the direction of a current proceeding from the disk to the wire". This is tantamount to saying the current passes in one direction only, or that rectification has taken place.

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Relation of Radon to Non-active Air Contamination

Anderson, Mayneord and Turner[1] have directed attention to the variation of atmospheric radon content. It may be of interest to note that similar observations were made here during the four months, November–February, 1953–54. Samples were collected daily from air drawn through four-inch filter paper *TFA*-41. The activity of the papers was determined by inserting them directly into an ionization chamber with a vibrating-reed type amplifier

and an inked pen recorder. A second set of observations was obtained by the more laborious counting of beta-emission with a mica window counter.

Identification of the activity as radon products was obtained by tracing the decay through periods longer than two hours, and indicated that the majority of activity was of this origin, although a tail of activity of longer life, probably thoron, could also be traced. No attempt was made to identify the type of dust collected; but its density was measured by comparing the light transmitted to that of a clean filter paper by a photoelectric densitometer. Although variations in radon over this period were considerably less (under a 20 to 1 maximum) than instances quoted by Anderson *et al.*, the correlation with dust present was strikingly evident. The correspondence with visibility was observed but less amenable to exact quantitative check.

These observations were taken in Morgantown, West Virginia, where coal is a common domestic and commercial fuel. Observations with improved apparatus are now in progress.

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Control of Diurnal Rhythms of Activity in *Periplaneta americana* L.

In a previous communication[1] it has been shown that a secretion carried in either the blood or tissues is involved in the production of a diurnal rhythm of activity in *Periplaneta americana* L.

It has now been found that the sub-œsophageal ganglia can in certain conditions evoke a diurnal rhythm of activity. The normal diurnal rhythm, consisting of a burst of activity in the first hours of darkness followed by a decrease in activity and finally a very low level of activity in the light, is disrupted by the removal of the head of a cockroach. Implantation of sub-œsophageal ganglia into headless cockroaches is found to be followed, in constant light or darkness, by an activity rhythm closely similar to that of the donor cockroach. The presence of neurosecretory cells in the sub-œsophageal ganglion has been demonstrated by Scharrer[2], and it would seem reasonable to suppose that they are concerned in the above effect.

Further experiments suggest that the ocelli are the sensory receptors acting as overall timekeepers or governors for the rhythm. Cutting the ocellar nerves, or destroying or covering the ocelli, results in a gradual loss of the normal rhythm, and in the production of a new active phase during the light period. There is a higher activity during this phase than was shown in the light period by beheaded and implanted cockroaches; the increase is probably the result of stimulation of the compound eyes, since it is eliminated if these are blackened.

After a period in constant darkness, cockroaches with cut ocellar nerves will not take up a rhythm of activity under new light conditions, provided that the compound eyes are covered. If the eyes are normal, then the cockroach is active in the light period but shows no carry-over of the rhythm in constant darkness. It is therefore not showing a true diurnal rhythm, which implies an ability to carry over the old rhythm under uniform environmental conditions rather than a simple reaction to immediate environmental effects. Covering the compound eyes alone and leaving the ocelli normal does not affect the rhythm.

Implanting a sub-œsophageal ganglion from a cockroach which has a normal rhythm into an intact cockroach which has been kept in constant darkness or light and has lost its rhythm causes the implanted cockroach to take up a normal rhythm. On the other hand, implanting a sub-œsophageal ganglion into an intact cockroach having the same rhythm as the donor does not cause any change in rhythm but is followed by a depression in the level of activity in the dark period.

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Digestion and the Production of Sulphuric Acid by Mollusca

While investigating the food of aquatic Mollusca in Uganda, it was observed that cellulose in the gut contents was being digested. *Caelatura hauttecoeuri ruellani* (Bgt.), a bivalve, was selected for detailed study and also *Melanoides tuberculata tuberculata* (Müll.), a snail, which belongs to the Prosobranchia, some members of which possess a crystalline style[1].

Preliminary experiments showed that cellulase contained in the crystalline styles of both *Caelatura* and *Melanoides* was more active at *p*H 5·5 than at *p*H 7·0, and that the alimentary canal in both species had an acid reaction.

Style material, obtained from several specimens of *Caelatura*, was dissolved in a citric–phosphate buffer solution at *p*H 5·5 and its effect observed on a uniform suspension of precipitated cellulose[2,3]. Aliquot portions of the cellulose suspension and style solution were dispensed into duplicated series of small test-tubes and incubated at 24° C. for 36 hr. At the end of this period, the amount of cellulose remaining was determined by turbidity methods, and any soluble sugars produced were estimated by means of alkaline picric acid. The results showed a reduction of cellulose and a rise in sugar content in those tubes containing style material. Similar results were obtained using style material from *Melanoides*.

A small amount of a commercial preparation containing penicillin and streptomycin was added to one set of tubes; this did not prevent hydrolysis of the substrate. Another set of tubes was boiled and immediately cooled. No cellulase activity was observed after this treatment. It seems, therefore, that the cellulase enzymes present in the styles of these two molluscs are similar to those found in the oyster and mussel[3].

Experiments were carried out to determine whether style solution was active against the cell walls of algae. Phytoplankton from Lake Victoria and two species of filamentous alga were used as a source of cellulose in experiments similar to the above. Breakdown of the cell walls of many of the Green and Blue-Green Algae present was observed. It seems that these molluscs are able to utilize sources of food largely unexploited by other groups of aquatic

herbivores. The diatom flora was not affected by the cellulase, a result in keeping with the siliceous nature of their cell walls. Apparently undamaged and viable diatoms are found frequently in snail fæces. This contrasts strongly with the fact that these plants form a very important part of the food of other herbivores[4].

A short length of gut, including the crystalline style, was taken from several specimens of *Melanoides*, macerated in a drop of distilled water and centrifuged. The supernatant solution was then analysed in order to determine the nature of the acid secreted. The chloride content did not prove high enough for estimation, but sulphate was present in a concentration of approximately 3·0 gm. per litre. This is of particular interest as sulphates in the waters and soils around Lake Victoria are present only in very small amounts and are frequently undetectable by normal chemical methods. Similar results were obtained using material from *Caelatura*.

A direct estimation was made of the inorganic solutes liberated into a small volume of water by various species of snails. In one experiment with *Melanoides*, for example, 0·05 mgm. sulphate was produced per snail in 12 hr.

It has been suggested that the fertility of many lakes in East Africa is controlled by the availability of dissolved sulphate[5], and by the activity of herbivores[6]. The observations indicate that both gastropods and bivalves have a favourable effect on fertility from both these points of view. Further work on these and other molluscs may show that their metabolism, in those waters in which they are abundant, has a significant effect on fertility.

I am grateful to Mr. C. C. Cridland of this Organization for identifying the Mollusca named above.

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Reappearance of *Ocenebra erinacea* (L.) off the East Coast of England

On the east coast of Britain three genera of Muricid drills, *Nucella*, *Urosalpinx* and *Ocenebra*, attack lamellibranchs. Of these, *Nucella* appears to have maintained its population status; but the abundance of the other two has undergone considerable changes. *Urosalpinx*, the American whelk tingle, has gradually increased during this century[1], whereas *Ocenebra* has twice suffered virtual extinction on the east coast by cold winters: 1928–29 [2] and 1939–40 followed by 1940–41 [3]. So far as is known, *Ocenebra* on the south coast of England was not affected.

There are now signs of reappearance of *Ocenebra* on the east coast. Newell[4] has found living specimens at Whitstable. Although none was found in recent surveys of the Rivers Roach, Crouch, Blackwater, Colne and Orwell, nor in Hamford Water, viable spawn has been found in Orford River. A substantial area has been trawled and dredged regularly since 1950 off Clacton-on-Sea and the approaches to the River Colne, but only dead shells of *Ocenebra* were recorded. In August 1954, however, in three separate hauls, five live *Ocenebra* were taken from the trawl near the Priory Spit buoy, two miles south-east of the mouth of the River Colne. In September 1954 two further live *Ocenebra* were taken from near the Outer Ridge buoy, about one mile south-east of the mouth of the Rivers Stour and Orwell. The specimens were all small, mostly of no more than about one to two years old.

The appearance of young individuals, in an area previously free from adult *Ocenebra*, indicates the beginning of recolonization. It may be significant that the competitor *Urosalpinx* has not so far been recorded in Suffolk.

It will be interesting to observe whether *Ocenebra* can re-establish itself in the rivers of Essex, in view of the large numbers of *Urosalpinx* there.

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Control of Crabs with Crude BHC

Crabs, of which the commonest is *Sesarma africanum*, H. M. Edw., are numerous on the tidal rice lands of Sierra Leone and destroy large numbers of newly planted rice seedlings. In normal farming practice, this has little appreciable effect on yields as sufficient seedlings are planted in each stand to allow for losses. In the past three years, however, there has been a considerable increase in the crab population on the farm of the West African Rice Research Station, and serious damage has been caused to experimental material.

Control of these crabs is complicated by the fact that river water is used for drinking purposes by the local population and that fishing is widespread. Generally toxic substances cannot, therefore, be used.

Preliminary experiments have now shown that crude BHC is effective against the crabs as a contact poison. The results of prolonged contact with aqueous suspensions of varying concentrations were as follows:

65 p.p.m. crude BHC caused death within 4 hr.
6·5 p.p.m. crude BHC caused death within 24 hr.
0·65 p.p.m. crude BHC caused complete lack of co-ordination within 24 hr. but no death within 72 hr.
0·065 p.p.m. crude BHC, no effect observed.

After momentary contact with a concentration of 650 p.p.m. crude BHC followed by thorough washing, death was caused within 24 hr., and under field conditions spraying with concentrations as low as 325 p.p.m. gave adequate protection to young rice seedlings.

These trials were carried out in a season of high tides and heavy rain, and it is probable that during the dry season even greater economy of spray could be obtained.

The investigations are being continued. Other methods of control are also being tried.

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Deoxyribonucleic Acid and Ribonucleic Acid in Hyphal Cells of Higher Fungi

THE importance of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) in the physiology of a cell is very great. Very little work on cells of fungal hyphæ seems to have been done. For this purpose, very young (2–3 days old) subcultures of *Polyporus ostreiformis*, *Polyporus adustus*, *Polyporus gilvus* and *Marasmius campanella* were taken; they were fixed and stained for 15–20 min. by the method of Unna as adapted by Brachet[1]. The small resting nuclei of the homogeneous unexpanded type of Pinto Lopes[2] became very prominent in pyronin-stained cytoplasm; nucleolus and chromatin, combined at the centre into a homogeneous mass, took brilliant green stain (DNA) surrounded by pink hyloplasm (RNA), and finally by a green outline (Fig. 1). The nucleolus, according to Brachet[3] and Caspersson[4], is believed to be composed mainly of ribonucleoproteins, and Fujii[5] holds that zinc, in addition, is present in nucleoli and that, upon the initiation of mitosis, zinc passes into chromosomes and possibly also into prometaphase spindle.

Nuclei of fungal hyphæ being extremely small, Unna staining will be of additional help in distinguishing the haploid from the diploid states by the respective sizes of the nuclei.

DNA in the nuclei is rather of a transitory nature, hence all the nuclei in a mycelium do not take the same prominent methyl green stain. There are differences of opinion as to whether DNA becomes prominent in the nuclei immediately before mitosis or during the early stages of prophase.

In Cyanophyceae the presence of a distinct nucleus (central body) is a matter of dispute. Biswas[6], working with *Oscillatoria* and *Calothrix* species of this group, could not obtain the methyl green stain of the central body (that is, the presence of DNA), and he thinks that DNA has not been highly polymerized in this lower group. Kurnick[7] holds that DNA is in a highly polymerized state and RNA is in a non-polymerized state, and therefore DNA takes on methyl green stain and RNA takes on pyronin stain. The specific character of these two dyes for the two nucleic acids has been confirmed by Sharma and Bhattacharjee[8] working on different plant materials (*Allium cepa*, *Zephyranthus longifolia*, etc.).

Evidence has been brought forward to show that ribonucleic acid plays an important part in protein synthesis[9], while accumulation of data by S. Zamenhof[10] strongly suggests that the composition of deoxyribonucleic acid is independent of the environment and, as such, it seems to be a hereditary determinant.

It is hoped that further work will gradually clarify these points.

Note added in proof. From Ledoux's (*Nature*, **175**, 258; 1955) recent communication, it appears that cellular multiplication of proliferating cells in carcinomata of mouse and rat can be modified through changes in the level of ribonucleic acid by the administration of ribonuclease both *in vitro* and *in vivo* experiments with animals. This, he holds, compares favourably with the results obtained with amphibian eggs and with those of Brachet (*Nature*, **174**, 876; 1954) with onion root tips; ribonuclease diffusing across the cell membrane has a very clear anti-mitotic effect.

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Fig. 1. *Marasmius campanella*. Arrow shows the nucleus close to the clamp connexion. (× 1,800)

Effect of Sodium Chloride on Softening and Carbohydrate Changes of Date Fruits

USUALLY Egyptians prefer to consume the date fruits when they are soft (ripe). This softening is either reached normally when the fruits are still on the tree, or it may be hastened by pretreatment of the mature fruits with an aqueous solution of sodium chloride. The latter observation inspired us to study the effect of different concentrations of sodium chloride on the rate of softening of the date fruits as well as on the carbohydrate changes.

The date fruits used in this experiment were picked from one tree and were segregated into homogeneous batches according to the procedure previously suggested by Nada[1]. Only the fruits with the highest sugar content were used in the present experiment. These were divided into five equivalent lots, one of which was sliced and extracted in hot alcohol (seed excluded) and finally analysed for the initial carbohydrate fractions. The remaining lots were sterilized in 2 per cent hydrogen peroxide for five minutes, after which each of the lots was soaked for six hours in one of the following solutions: (1) distilled water, (2), (3) and (4) solutions containing 2, 5 and 10 per cent sodium chloride respectively. At the expiry of this experimental period, the dates were again sterilized in hydrogen peroxide, rinsed well with sterile distilled water and finally blotted dry.

After this pretreatment each lot of dates was placed in a well-aerated dark chamber at temperature 30° C., and the experiment continued for 60 hr., after which the softness of the fruits was compared and then they were analysed for their carbohydrate fractions.

It appeared that the dates that had been soaked in solutions 3 and 4 were completely soft; whereas

the other lots either showed only slight signs of softening (that in solution 2), or not at all (control in solution 1).

Table 1 shows the carbohydrate content of the date fruit samples before and after experiment calculated in terms of gm. glucose per 100 gm. initial fresh weight.

Table 1

Pretreatment	Reducing sugars	Sucrose	Poly-saccharides	Total
Initial	3·58	22·27	1·06	26·91
6 hr. dis. water + 60 hr. air	6·46	18·84	1·06	26·36
6 hr. 2 per cent NaCl + 60 hr. air	6·80	17·10	1·04	24·94
6 hr. 5 per cent NaCl + 60 hr. air	19·75	3·07	0·95	23·77
6 hr. 10 per cent NaCl + 60 hr. air	19·90	0·93	0·72	21·55

Table 1 reveals that presoaking in distilled water apparently induced decrease in sucrose with a more or less corresponding increase in the reducing sugars. Presoaking in sodium chloride solutions accelerated the disappearance of sucrose and accumulation of hexoses, particularly when 5 and 10 per cent sodium chloride solutions were used. Indeed, the latter not only induced the rapid disappearance of sucrose but also a slight decrease in the polysaccharide content of the dates.

Softening therefore seems to be associated with accumulation of reducing sugars at the expense of sucrose and possibly also some polysaccharides.

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[1] *Nature*, **175**, 469 (1955).

A New Method for Determination of Thickness of Microtome Sections

A method for determining the thickness of microtome sections with the same accuracy as the rest of the analytical procedure has long been required in quantitative cytochemistry. Hitherto this has not been possible, and it has generally been necessary to estimate thickness from the microtome setting, a rather unsatisfactory method.

In 1936 Schmaltz described[1] a method for measuring the profile structure of a surface. This method, the so-called light-cut or light-profile technique, has been further developed by Naumann[2], Menzel[3] and Tolansky[4]. Besides the normal microscopical picture of the object, it also gives information about the depth of profile. A microscope for incident illumination is used in which the objective simultaneously acts as a condenser, and in which the illumination is adjusted according to the Kohler principle. An opaque wire or a phase edge is placed in the plane of the field iris diaphragm, the shadow of which is projected on to the surface under examination. By arranging off-central illumination, differences of level in the surface will give proportional displacements of the shadow line, thus giving the profile of the surface.

In an attempt to apply light-profile microscopy for thickness determinations of histological sections I have encountered certain difficulties. High accuracy is obtained only when the objective has a large aperture. However, the depth of focus is inversely proportional to the aperture, and since the two levels between which the measurement is made have to be relatively sharp in focus, the working-range is thus considerably reduced. In fact, if the highest possible accuracy is required, the maximum thickness to be measured in opaque objects is less than 2μ. For cytochemical work, the thickness of the sections generally exceeds 5μ, and it is therefore impossible to determine the thickness with satisfactory accuracy.

In the new method, the principle of the light-cut and light-profile method is employed; but only as an aid to focusing. The thickness proper (equivalent to the movement of the objective) is obtained by a mechanical measuring instrument, a 'mikrokator' (manufactured by C. E. Johansson, Eskilstuna, Sweden), attached to the microscope.

If a profile-microscope is focused on an even surface, the shadow is seen as a sharp line, slightly curved towards the periphery of the field of view. Defocusing in either direction leads to a parallel displacement of the line, which at the same time becomes unsharp and weaker in contrast. This parallel movement is symmetrical around the middle position as regards movement, sharpness and contrast. If a line in the ocular is superimposed upon the line of symmetry, this parallel displacement allows very accurate and reproducible focusing on two different levels in the object. These levels may, for example, be represented by the upper surface of a microtome section and the upper surface of the object slide, that is, the lower surface of the section. The difference between the two levels of focusing is, as mentioned above, measured by a 'mikrokator'. The measuring point of the 'mikrokator' rests upon a horizontal beam attached to that part of the microscope which is moved by the micrometer screw. A 'mikrokator' measuring a vertical movement of the object down to 0·1μ with an accuracy of $\pm$ 1 per cent is well suited for this purpose.

Just as in profile microscopy, the accuracy depends upon the structure of the object, the width, sharpness and contrast of the shadow and the aperture and magnification of the objective. In the present method, however, the accuracy is independent of the absolute thickness of the object, which may be as great as 100μ. The method is well suited for routine work, as one measurement involves only two focusings and two readings on the 'mikrokator', which then give the thickness directly in μ.

As a check upon the absolute accuracy of the method, ten measurements were made upon a layer of aluminium evaporated on glass. The average was: 3·71 $\pm$ 0·04μ; stand. dev. = $\pm$ 0·12μ. This compares well with the thickness measured by multiple interferometry: 3·72μ.

Sections of biological material embedded in paraffin, celloidin and plastic may be measured with approximately the same accuracy.

A more detailed report will be published later.

Olle Hallén

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Dec. 3.

[1] Schmaltz, G., "Technische Oberflächerkund" (Berlin, 1936).
[2] Naumann, H., *Bl. Unters. u. Forsch.-Inst.*, **16**, 25 (1942).
[3] Menzel, E., *Die Naturwiss.*, **14**, 332 (1951).
[4] Tolansky, S., *Nature*, **169**, 445 (1952); *Lab. Pract.*, 291 (1953).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, April 25

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. Max Black: "Wittgenstein's Tractatus".

Monday, April 25—Thursday, April 28

PHYSICAL SOCIETY (at the Royal Horticultural Society's New Hall, Westminster, London, S.W.1)—Exhibition of Scientific Instruments and Apparatus.

Discourses (Demonstration Lectures).

Monday, April 25
At 6.15 p.m.—Mr. M. E. Haine: "The Free Electron as a Tool in Scientific Research".

Tuesday, April 26
At 6.15 p.m.—Prof. J. Z. Young, F.R.S.: "Memory Systems in the Brain".

Wednesday, April 27
At 6.15 p.m.—Dr. G. F. J. Garlick: "Recent Developments in Luminescence and Its Applications".

Tuesday, April 26

INSTITUTION OF CHEMICAL ENGINEERS (at the May Fair Hotel, Berkeley Street, London, W.1), at 11 a.m.—Thirty-third Annual Corporate Meeting. 12 noon—Sir Harold Hartley, F.R.S.—Presidential Address.

ROYAL SOCIETY OF MEDICINE, MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 8 p.m.—Symposium on "Radioactive Isotopes". Speakers—Prof. E. E. Pochin, Prof. D. W. Smithers and Mr. Norman Veall.

ELECTRICAL ASSOCIATION FOR WOMEN (at the Royal Institution, Albemarle Street, London, W.1), at 9 p.m.—Sir Lawrence Bragg, F.R.S.: "Thirty Years of Electrical Progress".

Tuesday, April 26—Wednesday, April 27

SERVICES ELECTRONICS RESEARCH LABORATORY (at Baldock, Herts)—Symposium on "Intermetallic Semi-conductors".

Tuesday, April 26—Thursday, April 28

DUBLIN INSTITUTE FOR ADVANCED STUDIES, SCHOOL OF COSMIC PHYSICS (at 5 Merrion Square, Dublin)—Symposium on "Atmospheric Condensation Nuclei".

Wednesday, April 27

ELECTRICAL ASSOCIATION FOR WOMEN (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 9.45 a.m.—Thirtieth Annual Conference.

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the ROYAL SANITARY INSTITUTE, at the Town Hall, Bournemouth), at 10 a.m.—Discussion on "The Contribution of Processing Techniques to the Nutritional Value of Food".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting.

PHYSICAL SOCIETY, COLOUR GROUP (at the Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m.—Discussion on "The C.I.E. System and its Revision".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Prof. A. C. B. Lovell, F.R.S.: "Radio Astronomy and the Fringe of the Atmosphere" (Symons Lecture).*

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Dr. W. Idris Jones: "Fuel and Power Research in Britain".*

INSTITUTE OF PHYSICS, INDUSTRIAL SPECTROSCOPY GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. A. G. Gaydon, F.R.S.: "Spectroscopic Evidence on the State of Equilibrium in Flame Gases".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. K. J. Coppin: "Suppressed Aerials for the Aircraft H.F. Band".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Annual General Meeting, followed by Dr. J. C. Hudson: "Some Thoughts on the Practice of Applied Science" (Chairman's Address).

Wednesday, April 27—Thursday, April 28

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1)—Annual General Meeting.

Thursday, April 28

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. M. L. E. Oliphant, F.R.S.: "The Acceleration of Charged Particles to Very High Energies" (Bakerian Lecture).

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. C. Moore: "A Survey of Some of the Recent Developments in Homotopy Theory".

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. M. F. Carroll: "The Commonwealth as a Source of Essential Oils".

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Department of Imperial College, Imperial Institute Road, London, S.W.7), at 5.40 p.m.—Prof. R. Morse: "Wave-guide Propagation in Acoustics".

WOOL EDUCATION SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 7.15 p.m.—Prof. E. J. Roberts: "Sheep and Wool from the Hills".

Friday, April 29

BRITISH GLACIOLOGICAL SOCIETY (in Room 5, Main Building, The University, Edgbaston, Birmingham 15), at 5.30 p.m.—Prof. F. W. Shotton: "The Midlands in British Pleistocene Geology".

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Dr. I. I. Sikorsky: "The Transport Helicopter" (James Clayton Lecture).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN BOTANY—The Registrar, The University, Hull (April 30).

ASSISTANT LECTURER or LECTURER (preferably with specialist knowledge of systematic botany) IN THE DEPARTMENT OF BOTANY—The Registrar, The University, Liverpool (April 30).

LECTURER IN THE DEPARTMENT OF GEOGRAPHY—The Registrar, The University, Liverpool (April 30).

LECTURER or ASSISTANT LECTURER IN PHYSICS—The Registrar, The University, Sheffield (April 30).

LECTURER (with a degree in mathematics or statistics and with suitable teaching and/or industrial experience) IN MATHEMATICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (April 30).

LECTURER (with special interests in fluid mechanics) IN ENGINEERING, and a LECTURER IN METAL PHYSICS—The Registrar, University College, Singleton Park, Swansea (April 30).

CHAIR OF PHYSIOLOGY at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (May 5).

LECTURER (honours graduate in metallurgy, and preferably with experience in research and in production metallurgy) IN METALLURGY—The Registrar, College of Technology, Manchester 1 (May 7).

LECTURERS (3) IN STATISTICS—The Secretary, The University, Aberdeen (May 7).

PHYSICAL CHEMIST or BIOCHEMIST (with an interest in the application of physical methods to biological problems, and preferably with research experience, a knowledge of X-ray diffraction, or ability to handle small quantities of biological material) to join a small team engaged in fundamental research on the structure of plant viruses—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (May 7).

SENIOR LECTURER (graduate of a British university, and with good industrial experience) IN TELECOMMUNICATIONS, and a LECTURER (Grade B) (graduate of a British university, and with industrial experience) IN ELECTRICAL ENGINEERING—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11 (May 7).

LECTURER (first-class honours graduate in mathematics, preferably with a special interest in some branch of applied mathematics or in statistics) IN MATHEMATICS—The Registrar, College of Technology, Manchester 1 (May 9).

LECTURER (with high academic qualifications and research experience, and with special interests in inorganic chemistry) IN THE DEPARTMENT OF CHEMISTRY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (May 9).

LECTURER IN ZOOLOGY at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (May 9).

SENIOR LECTURER or LECTURER (with qualifications and experience in chemical engineering) for teaching and research in the sub-department of CHEMICAL TECHNOLOGY, and a LECTURER IN ORGANIC CHEMISTRY, at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (May 9).

CHAIR OF ELECTRICAL ENGINEERING, and CHAIR OF MECHANICAL ENGINEERING—The Registrar, University College, Singleton Park, Swansea (May 14).

LECTURER (with a good honours degree, either in electrical engineering or in mathematics and physics, and preferably with suitable experience in research and teaching in radio and electronics) IN ELECTRICAL ENGINEERING—Joint Clerk to the University Court, Queen's College, Dundee (May 15).

LECTURER (preferably with research interests in spectroscopy or the kinetics of gaseous oxidation processes) IN PHYSICAL CHEMISTRY—Joint Clerk to the University Court, Queen's College, Dundee (May 16).

LECTURER (with a good honours degree in engineering, and preferably with teaching and research experience in a branch of applied mechanics) IN THE DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING—Joint Clerk to the University Court, Queen's College, Dundee (May 18).

READER IN PHYSICAL CHEMISTRY at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 18).

LECTURER IN FLUID MECHANICS in the Department of Aeronautics and Fluid Mechanics—The Secretary of University Court, The University, Glasgow (May 20).

PROFESSOR OF APPLIED ELECTRICITY AND HEAD OF DEPARTMENT—The Secretary and Registrar, University College of North Wales, Bangor, N. Wales (May 23).

LECTURER or ASSISTANT LECTURER IN INORGANIC AND STRUCTURAL CHEMISTRY, and a LECTURER or ASSISTANT LECTURER IN PHYSICAL CHEMISTRY—The Registrar, The University, Leeds 2 (May 28).

READER IN MARINE BIOLOGY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, May 31).

PROFESSOR OF THEORETICAL PHYSICS; READER IN THEORETICAL PHYSICS; SENIOR FELLOW; FELLOW; SENIOR RESEARCH FELLOWS and RESEARCH FELLOWS IN THE RESEARCH SCHOOL OF PHYSICAL SCIENCES, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 30).

ASSISTANT, Grade B (with a degree in chemistry or A.R.I.C., and preferably with industrial and teaching experience), FOR CHEMISTRY to higher national certificate, at Widnes College for Further Education—Borough Education Officer, Lugsdale Road, Widnes.

ASSISTANT PROFESSOR OF MATHEMATICS—The President, Memorial University of Newfoundland, St. John's, Newfoundland, Canada.

LABORATORY TECHNICIAN (Physics)—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1.

LECTURER or ASSISTANT LECTURER IN PHYSICS—The Registrar, The University, Nottingham.

LECTURER (with an honours degree in zoology, and preferably with teaching experience) IN CHARGE OF BIOLOGY—The Principal, Technical College, Queen Street South, Huddersfield.

READER, SENIOR LECTURERS or LECTURERS (preferably with experience in analytical inorganic chemistry or physical chemistry) IN CHEMISTRY—The Dean, College of Arts and Sciences, Baghdad, Iraq.

SENIOR LECTURER IN THE DEPARTMENT OF MATHEMATICS, Technical College, Bradford—The Director of Education, Town Hall, Bradford.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (honours graduate (first- or second-class) in science, preferably agricultural chemistry) to carry out research on energy and protein metabolism of animals—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with at least a second-class honours degree in physics) IN THE ISOTOPE SCHOOL, to lecture on nuclear physics radioactivity and instruments used in measuring radioactivity; to advise students on physical problems in the use of isotopes; and to develop new instruments and techniques in connexion with the teaching of the Isotope School—The Establishments Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/232.

TECHNICAL ASSISTANTS (with Inter.B.Sc. or equivalent qualification, with chemistry as main subject) in the Central Laboratory, London Transport, Chiswick—The Staff Officer (F/EV. 530), London Transport, 55 Broadway, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Book Supplement)

Great Britain and Ireland

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1953–54. West Indies. By J. V. Lochrie, J. R. Spence and C. T. Cave. Pp. 19. 9*d*. Nyasaland. By H. C. Ducker. Pp. 9. 9*d*. (London: Empire Cotton Growing Corporation, 1954.) [72

National Research Development Corporation. Report and Statement of Accounts for the year 1st July, 1953 to 30th June, 1954. Pp. 20. (London: H.M. Stationery Office, 1955.) 9*d*. net. [72

Short Course of German Reading for Students. By Dr. W. F. Jepson. Pp. 8. (Sunninghill: W. F. Jepson, 1954. Obtainable from H. K. Lewis and Co., Ltd., London, W.C.1.) 1*s*. 6*d*. [72

The Registrar General's Statistical Review of England and Wales for the year 1951. Text volume. Pp. xiii+312. (London: H.M. Stationery Office, 1954.) 10*s*. net. [72

Orthocide Wettable 50% Captan: Report of Trials conducted in Great Britain and Ireland during 1954. Second edition, January 1955. Pp. 32+12 tables. (Wheathampstead: Murphy Chemical Company, Ltd., 1955.) [72

Regional Advisory Council for Higher Technological Education: London and Home Counties. Sixth Annual Report, 1953–54. Pp. 40. (London: Regional Advisory Council for Higher Technological Education, 1955.) [72

National Coal Board: Scientific Department. Science Bulletin—Autumn, 1954. (No. 3.) Pp. 15. (London: National Coal Board, 1954.) [72

Shell Photographic Catalogue. 132 pages of additions to Volumes 4 and 5. (London: Shell Petroleum Co., Ltd.) [72

Sperry Synchros: Design—Theory—Application. Pp. 72. (Publication 652.) (Brentford, Mddx.: Sperry Gyroscope Co., Ltd., 1954.) [72

The Partnership of Science and Engineering. By Sir Edward Appleton. (Twenty-third Andrew Laing Lecture, delivered before the North East Coast Institution of Engineers and Shipbuilders, in Newcastle upon Tyne on the 10th December, 1954.) Pp. ii+10. (Newcastle upon Tyne: North East Coast Institution of Engineers and Shipbuilders; London: E. and F. N. Spon, Ltd., 1955.) 3*s*. 6*d*. [72

Colonial Office. Colonial Development and Welfare Acts. Report on the administration and use of the Funds provided under the Colonial Development and Welfare Acts. Pp. 32. (Cmd. 9375.) (London: H.M. Stationery Office, 1955.) 1*s*. net. [152

Ministry of Agriculture and Fisheries. Department of Agriculture for Scotland. Myxomatosis: Second Report of the Advisory Committee on Myxomatosis. Pp. ii+6+1 map. (London: H.M. Stationery Office, 1955.) 1*s*. net. [152

Council for the Promotion of Field Studies. Annual Report, 1953–54. Pp. 60+8 plates. (London: Council for the Promotion of Field Studies, 1955.) [152

University of Cambridge. Report of the Observatories Syndicate for the year ending 1954, September 30. Pp. 4. (Cambridge: The University, 1955.) [212

Carnegie Trust for the Universities of Scotland. Fifty-third Annual Report (for the year 1953–54). Pp. iv+72. (Edinburgh: T. and A. Constable, Ltd., 1955.) [212

Department of Scientific and Industrial Research. Forest Products Research Laboratory. Leaflet No. 47: The Movement of Timbers. Pp. 6. Leaflet No. 48: Hardwoods for Industrial Flooring. Pp. 12. (Ayles: Forest Products Research Laboratory, 1954.) [212

West African Cacao Research Institute. Annual Report—April 1953 to March 1954. Pp. 52. (London: Crown Agents for Overseas Governments and Administrations, 1954.) 5*s*. [212

Other Countries

South Africa. Council for Scientific and Industrial Research, Library and Information Division, Pretoria. Register of Current Scientific Research at South African Universities. Pp. viii+262. (Pretoria: Council for Scientific and Industrial Research, Library and Information Division, 1954.) [72

Sudan Government. Ministry of Agriculture. Bulletin No. 15: Notes on Cotton Growing from the Research Division. By H. Ferguson. Pp. 52. (Khartoum: Agricultural Publications Committee, 1954.) [72

World Health Organization. Technical Report Series No. 87. Expert Committee on Onchocerciasis. First Report. Pp. 37. (Geneva: World Health Organization; London: H.M. Stationery Office, 1954.) 1*s*. 9*d*. net; 0.25 dollars; 1 Swiss franc. [72

The Role of the Pituitary in Cancer: the Clinical Value of Pituitary Lipid Treatment. By Dr. Henry K. Wachtel. Pp. 31. (New York: The William-Frederick Press, 1954.) 2 dollars. [72

Smithsonian Institution. Report of the Secretary and Financial Report of the Executive Committee of the Board of Regents, for the year ended June 30, 1954. Pp. ix+175+4 plates. (Smithsonian Publication 4182.) (Washington, D.C.: Government Printing Office, 1955.) [72

South African Council for Scientific and Industrial Research. List of Abbreviations of Names of Societies, Organisations, etc. Compiled by the Library and Information Division. Pp. iv+51. (Pretoria: South African Council for Scientific and Industrial Research, 1955.) [72

Transactions of the American Philosophical Society. New Series—Vol. 44, Part 6: The Illumination and Polarization of the Sunlit Sky on Rayleigh Scattering. By S. Chandrasekhar and Donna D. Elbert. Pp. iv+643–654+12 tables. (Philadelphia: American Philosophical Society, 1954.) 2 dollars. [72

Essai de Prévention de la Silicose. Par L. Dautrebande, D. Cartry, J. Van Kerkom et A. Cereghetti. Pp. 177. (Bruxelles: Union Minière du Haut-Katanga, 1954.) [72

American Philosophical Society. Cumulative Record of Exhibition Catalogues. The Pennsylvania Academy of the Fine Arts, 1807–1870; The Society of Artists, 1800–1814; The Artists' Fund Society, 1835–1845. Compiled and edited by Anna Wells Rutledge. Pp. v+450. (Memoirs of the American Philosophical Society—Vol. 38.) (Philadelphia: American Philosophical Society, 1955.) 6 dollars. [72

U.S. Department of Agriculture. Leaflet No. 380: The Wheat Jointworm: How to Fight it. Pp. 8. (Washington, D.C.: Government Printing Office, 1954.) 5 cents. [72

Trinidad and Tobago. Forest Department. Annual Administrative Report for the year 1953. Pp. 31. (Port-of-Spain, Trinidad: Forest Department, 1954.) [72

Sveriges Geologiska Undersökning. Ser. C. No. 530: Kvartärgeologiska Studier inom Rönneåns Dalbäcken i Nordvästra Skåne. Av Helge Tulström. Pp. 73+2 plates. 3 kronor. Ser. C. No. 535: Die Mollusken und Brachiopoden der Schwedischen Kreide. 4: Die Mammiliaten- und Mucronatenkreide des Ystadsgebietes. Von Richard Hägg. Pp. 72+9 plates. 3 kronor. Ser. C. No. 536: A Telluride Assemblage in the Rudtjebäcken Pyrite Ore. Vesterbotten, N. Sweden. By Sven Gavelin. Pp. 14. 1 kronor. Ser. C. No. 537: Undersökning Berörande Spridning och Avsättning av i Vattnet Suspenderat Slam vid Utsjälpning av Mudder I Byfjorden Våren 1953. Av Jerlov och B. Kullenberg. Pp. 25. 2 kronor. Årsberättelse för År 1953. Pp. 3. (Stockholm: Kungl. Boktryckeriet, P.A. Norstedt and Söner, 1954.) [212

Det Kongelige Industri-, Håndverk- og Skipsfartsdepartement. Norsk Polarinstitutt. Skrifter Nr. 96: Geochemical Affinities of Some Coals from Svalbard. By J. R. Butler. Pp. 26. 3 kronor. Skrifter Nr. 98: The Barnacle *Balanus balanoides* (Linné, 1766) in Spitsbergen. By Rolf W. Feyling-Hanssen. Pp. 64+9 plates. 8 kronor. (Oslo: I Kommisjon hos Broggers Boktrykkeris Forlag, 1953.) [211

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